

Training Manual

SpectraPoint™ LMDS Basics

Issue 2

March, 2000

Part No. 3215393



SpectraPoint™ LMDS

Local Multipoint Distribution Services

Preface

To the student

This manual is written to provide an overview of Local Multipoint Distribution Services (LMDS) and the SpectraPoint SP2200 system.

Convention

The following textual convention is used in this manual:

Note: This is used for clarification of any topic being covered. Note is bolded, followed by a colon, and the note text is *italicized*.

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Training Manual

SpectraPoint™ LMDS Basics

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Section	Description
1	Introduction
2	Telecommunications Overview
3	LMDS Fundamentals
4	SpectraPoint™ Product Family
5	Base Station Overview
6	Customer Premises Equipment Overview
7	Operations Architecture
8	Acronyms



Class Introduction

Overview

This course is designed to give the student an introduction to the Local Multipoint Distribution Services.

Course Objectives

Given the necessary documentation, upon completion of this course, the student will be able to discuss the following topics:

- LMDS Fundamentals
- SpectraPoint SP2200 system
 - Base equipment
 - Node equipment
 - Customer Premises Equipment
- Operations Architecture

Slide 1-1

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LMDS Basics Class Introduction

See slide 1-1 for course objectives.



Class Information

- **Student Introductions**
- **Logistics**
- **Class Schedule**
- **Course Topics** Shown on the next slide

Slide 1-2

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Class Information

See the slide 1-2 for details.



Class Topics

- Telecommunications Overview
- LMDS Fundamentals
- SP2200 Base and Node Equipment
- SP2200 Customer Premises Equipment
- Operations Architecture

Slide 1-3

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Course Topics

See slide 1-3 for details.



Telecommunications Overview

Upon completion of this section, the student will be able to discuss the following telecommunications topics:

- Brief history of telecommunications
- Bandwidth terminology
- Growth of telecommunications
- Existing technologies
- Network access trends
- Telecommunications driving forces

Slide 2-1

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Telecommunications Overview

This section introduces Telecom from the LMDS point of view. The economic impact of LMDS will be stressed. See slide 2-1 for the section objectives.



A Brief History of Telecom

- 1876 Alexander Graham Bell Patents the "Talking Machine"
- 1893 Bell's Patent Expires - Competition Begins
- 1934 Federal Communications Act of 1934 - creates FCC
- 1968 The Carterphone Decision, the MCI Case
- 1984 Divestiture of the Bell System
- 1996 The Telecommunications Act of 1996
- 1998 U.S. LMDS Auction

Slide 2-2

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A Brief History of Telecom (Telecommunications)

See slide 2-2 for details.

Bandwidth Terminology	
Narrowband (0 - 128 Kbps)	• DS-0 (64 kbps) • Basic Rate Interface (128 kbps)
Midband (128 Kbps - 2 Mbps)	• H0 384 kbps • H1 768 kbps • T-1 1.544 Mbps /DS-1 • E-1 2.048 Mbps
Wideband (2 Mbps - 50 Mbps)	• E-3 34.68 Mbps • DS-3 44.74 Mbps = 28 x DS-1 • OC-1 51.8 Mbps
Broadband (> 50 Mbps)	• OC-3 155 Mbps (3 OC-1s) • OC-12 622 Mbps (4 OC-3s)

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$24 \times DS-0 = DS-1$
 $DS-1 = 1.544 \text{ Mbps}$
 $4 \times DS-1 = DS-2$
 $7 \times DS-2 = DS-3$

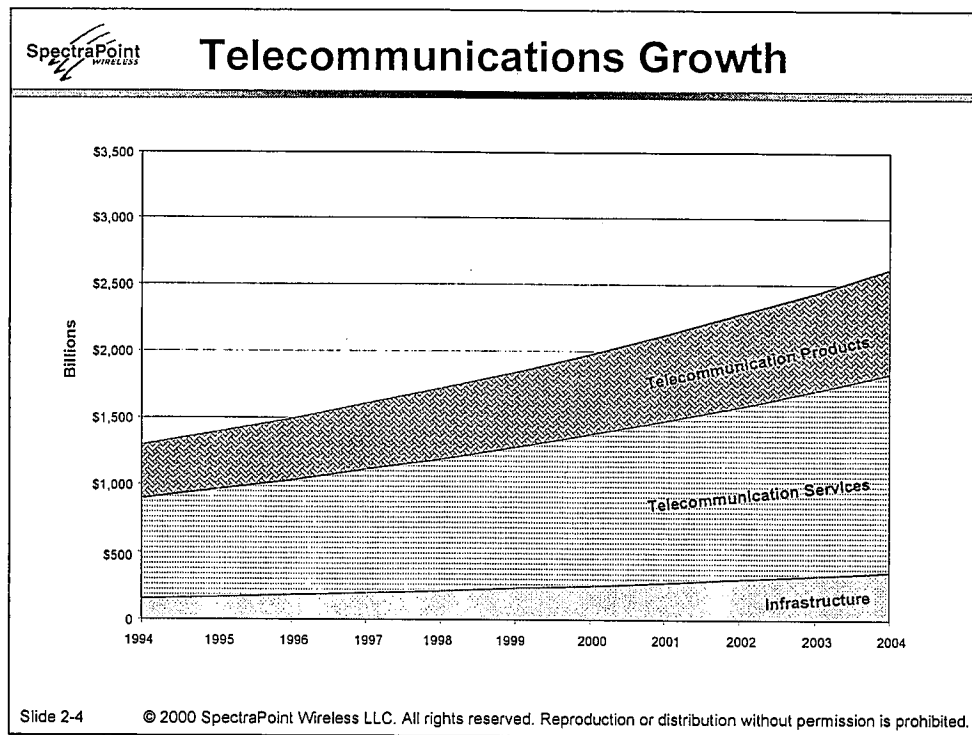
Bandwidth Terminology

Telecommunications until the late-'80s was primarily transported in the Narrowband range. In the '90s the bandwidth requirements grew dramatically with the advent of "smart" CPE equipment, educated users, and the explosive growth of data communications.

$BRI = 2 \times 3B @ 64K + 1 \times D @ 16K$ 128K usable
 signaling
 $PRI = 23 \times 3B @ 64K + 1 \times D @ 64K$

- *Midband* is a term originated by Microsoft Corporation. HO (H Zero) and H1 (H One) are Integrated Services Digital Network (ISDN) services. *Broadband* describes 50 Mbps or greater transport. **Note:** OC-x stands for Optical Carrier - Level x.

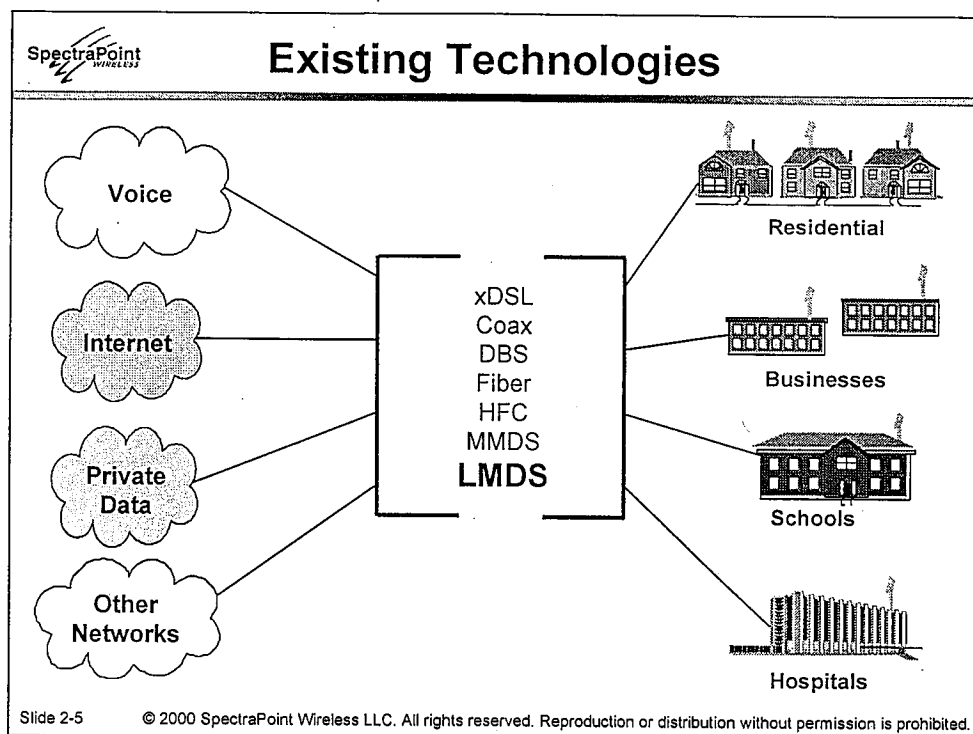
- End user connections
 - *Narrowband* and *Midband* are furnished to the end user on copper.
 - *Wideband* and *Broadband* are furnished on fiber optic.
- Optical deployments
 - SONET stands for Synchronous Optical NETWORK. It is deployed in the U.S. and Canada.
 - SDH (Synchronous Digital Hierarchy) is used in Europe and South America. SDH starts at STM-1 (Synchronous Transport Mode, a standard for transmission over fiber cable); STM-1 is the equivalent of OC-3.



Telecommunications Growth 1994 - 2004

The projected growth of the telecommunications industry from 1994 to 2004 is shown in the graph in slide 2-4.

Please note that the largest growth is expected in the *Telecommunications Services*, followed by *Telecommunications Products*. As expected, *Infrastructure* stays virtually flat with respect to the combined growth of the other sectors mentioned previously.



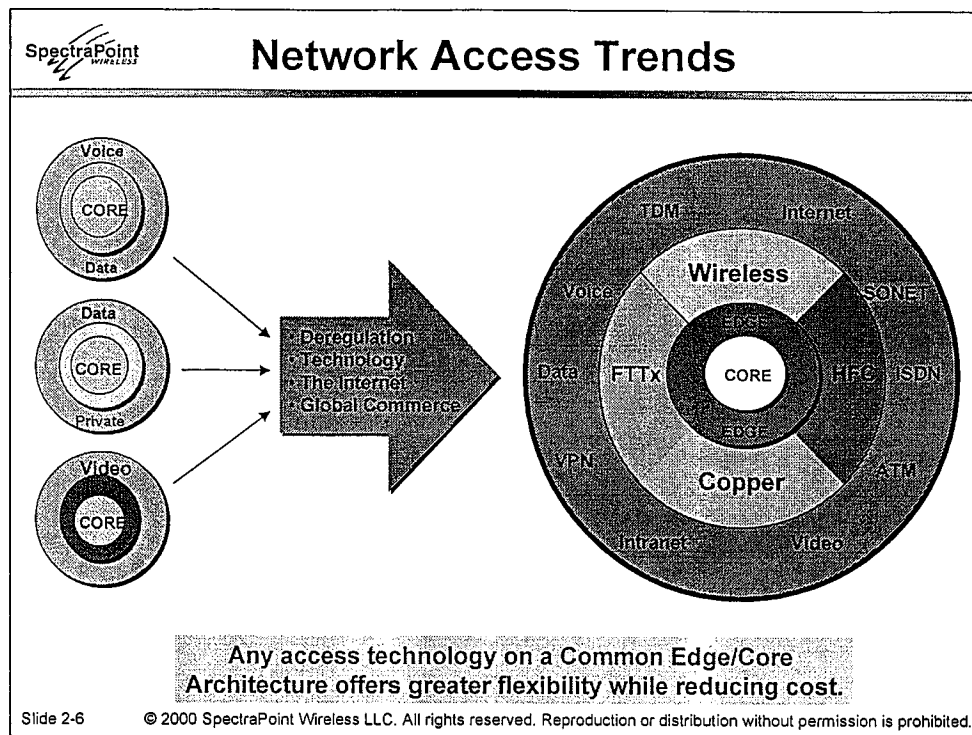
Existing Technologies

Shown on the left in the drawing in slide 2-5 are the different technologies used to deploy telecom services at this time. There are various ways to connect the user to each of these offerings.

LMDS (Local Multipoint Distribution Services) is one of the newest in this emerging marketplace, but all of them have a logical place. They are competing, but yet they are also complementary and share a synergy.

Acronyms shown in slide 2-5:

- | | |
|--------|---|
| • xDSL | "x" Digital Subscriber Line |
| • DBS | Direct Broadcast Satellite |
| • HFC | Hybrid Fiber Cable |
| • MMDS | Microwave Multipoint Distribution Service |
| • LMDS | Local Multipoint Distribution Service |



Network Access Trends

The drawing in slide 2-6 may best be viewed from the perspective of the Telecommunications (Telecom) industry of the 1970s and its transition to the 1990s. Depending on the location in the world, some of these technologies may just now be offered.

1970 - 1990

On the left are specific core technologies and at the outer perimeter of each core are access to these services. This was the state of Telecom during the 1970 - 1990 time period: technologies served specifics aspects, but there was not an integrated method of meeting customer needs.

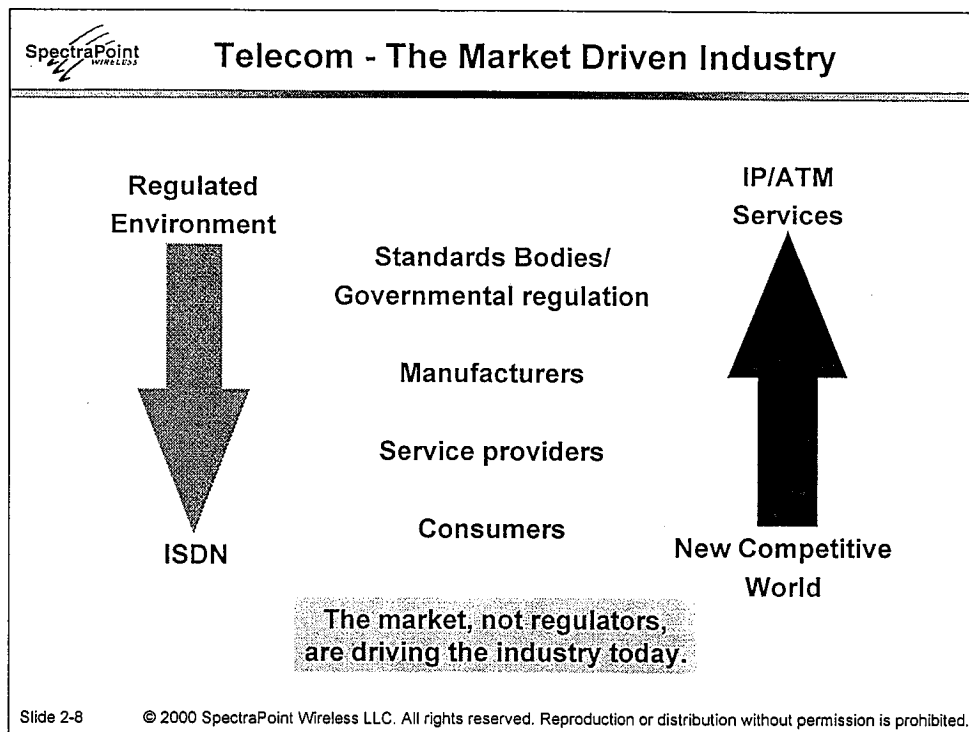
1990s

During the 1990s, this changed due to deregulation of the telephone industry worldwide, rapid technological changes, introduction of & changes in the Internet, and companies doing business on a global basis (international e-commerce). To the right in the drawing, the edge services are integrated and deployed at the customer premise via various methods - be it HFC, Copper (a.k.a. "twisted pair"), Fiber to the "x" (FTTx) or wireless.

Network Access Trends, continued

Acronyms used in slide 2-6

• SONET	Synchronous Optical Network
• ISDN	Integrated Services Digital Network
• ATM	Asynchronous Transfer Method
• VPN	Virtual Private Network
• TDM	Time Division Multiplexing



Telecommunications - the Market Driven Industry

In the drawing in slide 2-8, the left arrow represent the Telecom (Telecommunications) market being driven by the regulatory bodies/governmental products and services. This was the state of Telecom prior to the 1990s.

Today, the customer is driving the marketplace.

- Consumers make their wishes and needs known to the Service Providers.
- Service Providers, in turn, tell the Manufacturers what will sell and what won't.
- Standard Bodies then develop and adopt standards necessary to satisfy manufacture of these product and services to meet market needs.



LMDS Fundamentals

Upon completion of this section, the student will be able to recognize the following LMDS fundamentals:

- LMDS definition
- Benefits of LMDS
- LMDS history, global environment
- 28 GHz frequency plan
- Radio and RF transmitter technologies
- Frequency reuse
- Broadcast attenuation factors
- Line of sight (LoS)

Slide 3-1

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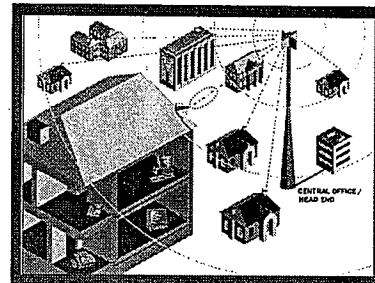
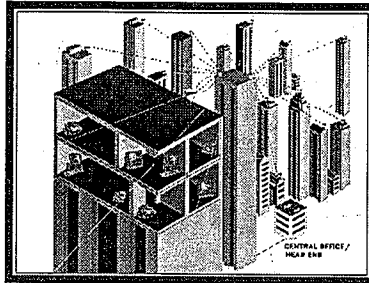
LMDS Fundamentals

This section provides an overview of LMDS fundamentals. See slide 3-1 for section objectives.



LMDS Definition

- Fixed Wireless @ 28 GHz
- Line of Sight Coverage (LoS)
- Multiple Service Offerings
- Target Deployment/Customers
- Multi-Sector Node Sites
- 3 - 5 Km Radius 'Cell' Sizes



Slide 3-2

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What is LMDS?

LMDS is the acronym for Local Multipoint Distribution Services. See slide 3-2 for the key features of LMDS.



Service Provider Benefits

- Rapid deployment at the customer's premises
- Versatility of service and bandwidth
- Customized, scalable installations
- Total management of the network
- Elimination of network duplications
- QoS guaranteed across the network

Slide 3-3

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LMDS Benefits - Provider

See slide 3-3 for details.



Subscriber Benefits

- Dramatically reduces waiting time
- One bill for all services
- Compatible with existing subscriber equipment
 - PBX
 - Channel bank
 - Router
- Flexible interfaces are supported
- Increased bandwidth readily available
- Only one number to call for repairs

Slide 3-4

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LMDS Benefits - Subscriber

See slide 3-4 for details.



LMDS History

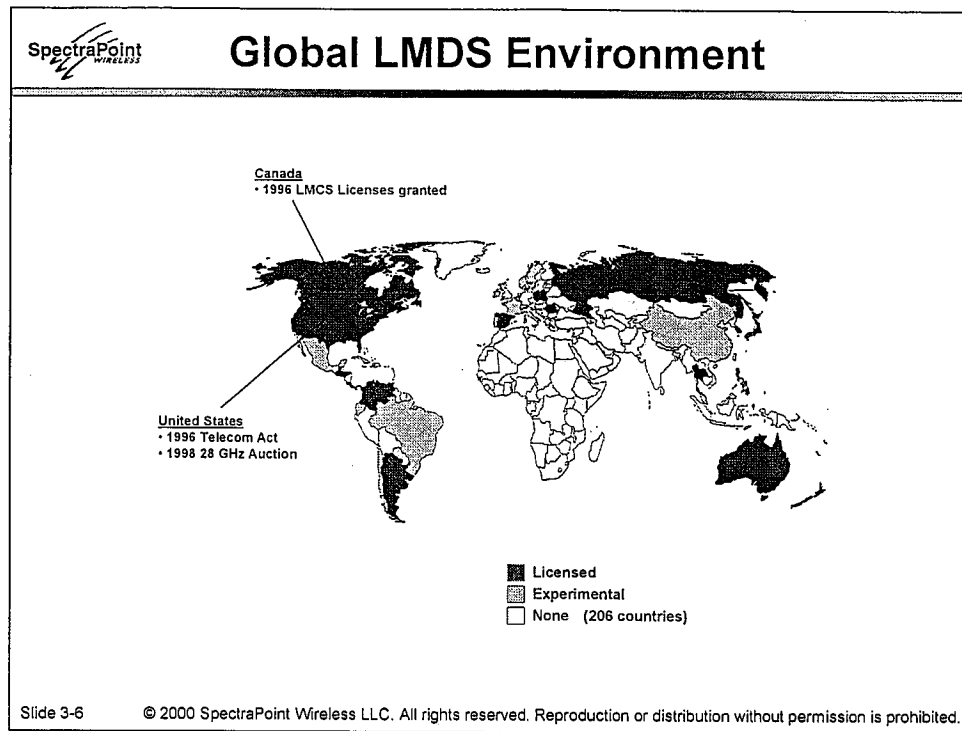
- 1994
 - Texas Instruments demonstrated LMDS Technology
 - Two-Way Transport of Voice, Internet, Video, and Interactive Gaming
- 1995
 - Texas Instruments integrated LMDS System Into HFC CATV Headend
 - Texas Instruments International Experimental Trial in Brazil
- 1996
 - Texas Instruments demonstrated Two-Way Digital Video Market Trial
 - Texas Instruments developed Solid-State Transmitters & Receivers
- 1997
 - Bosch Telecom demonstrated ATM 'Over-The-Air' at 28 GHz
 - HP and Stanford Telecom demonstrated prototype LMDS System
 - Texas Instruments LMDS becomes Bosch Telecom (June)
- 1998
 - Bosch Telecom deployed Multimedia LMDS Network in Dallas Showcase
 - World's first commercial demonstration: 6 virtual subscribers, 7 external subscribers
 - Customer trials in U.S., Canada, Argentina, Spain
- 1999
 - Bosch Telecom becomes SpectraPoint Wireless LLC (July)
 - SpectraPoint Wireless is co-owned by Motorola and Cisco

Slide 3-5

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LMDS History

See slide 3-5 for details.



Global LMDS Environment

- **International Frequencies:**

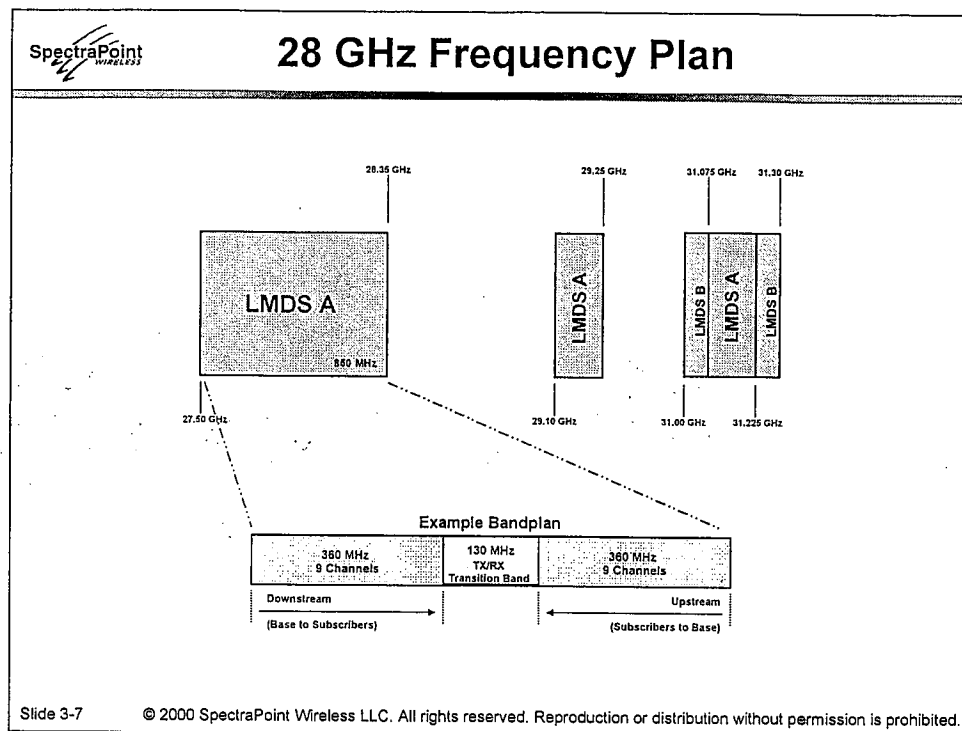
10, 15, 18, 23, 24, 26, 28, 38, 40 GHz

- **Commercial LMDS licenses awarded:**

Argentina, Australia, Canada, Colombia, Guatemala, New Zealand, Philippines, Poland, Romania, Russia, South Korea, Thailand, United States, and Venezuela

- **Experimental LMDS licenses granted in other countries**

Note: *This listing is current as of June, 1999.*



28 GHz Frequency Plan

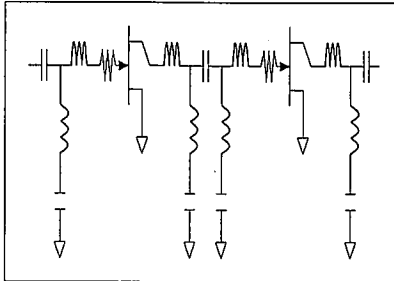
Shown in slide 3-7 is a graphic representation of the frequency plan for 28 GHz applications. The licensed Bands A and B for 28 GHz and 31 GHz spectrums are shown.

Note: The lower portion of the slide shows an deployment bandplan example. Bandplans are designed to suit customer application needs.



Radio Technology Used

GaAs MMIC's



Gallium Arsenide
Monolithic Microwave Integrated Circuits

Applications

- 1980s: Defense system radar
- 1990s: Electronic warfare systems
- Present: Communications

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Radio Technology Used

Gallium Arsenide Monolithic Microwave Integrated Circuits (GaAs MMICs) are used as the basis for our Transmitters. **Note:** The drawing in slide 3-8 is a simulated GaAs MMIC circuit; an actual drawing is not available, as this is a tightly held secret among those few companies that produce MMICs.



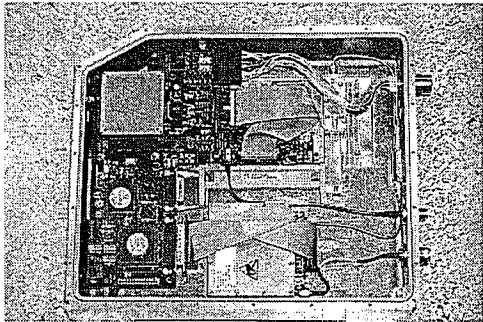
Transmitter Equipment

1980's Technology

- Traveling Wave Tube
- Advantages
 - Mature Technology
 - Higher Power Output (200 W)
- Disadvantages
 - High Maintenance
 - Shorter Life Expectancy

1990's Technology

- Solid State Electronics
- Advantages
 - Miniaturized Packaging
 - High Reliability
 - Lower Power Output (1-2 W)
 - Lower Life Cycle Cost
- Disadvantages
 - Evolving Technology
 - Limited Supplier Base

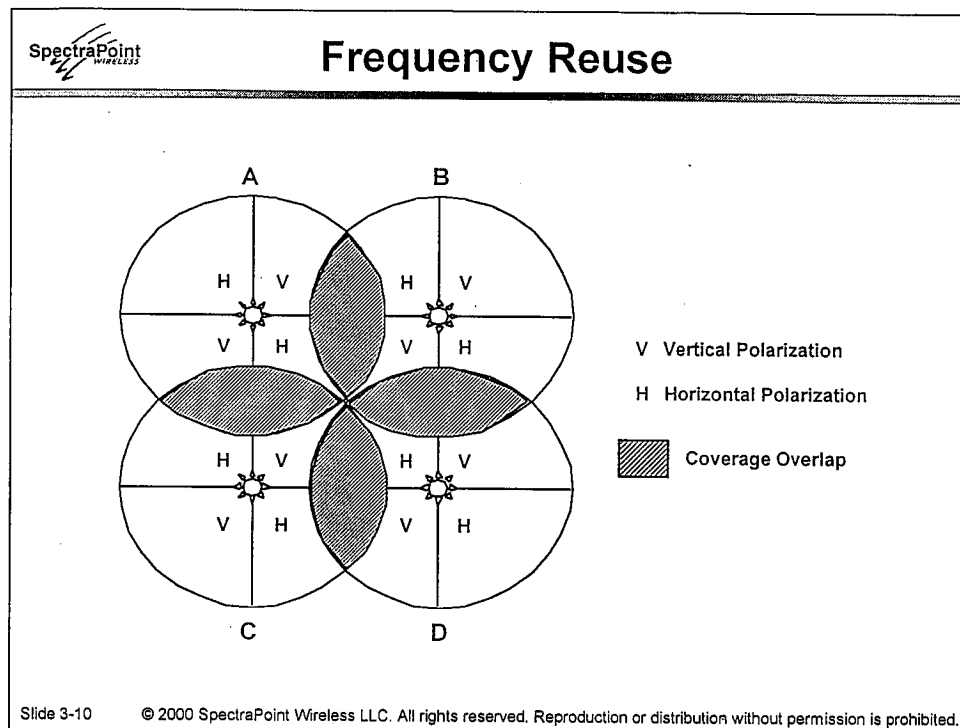


SP2200 Transmitter

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Transmitter Equipment

The digital board and associated electronic components inside an SP2200 Antenna are shown in slide 3-9. See the slide for transmitter technology information.



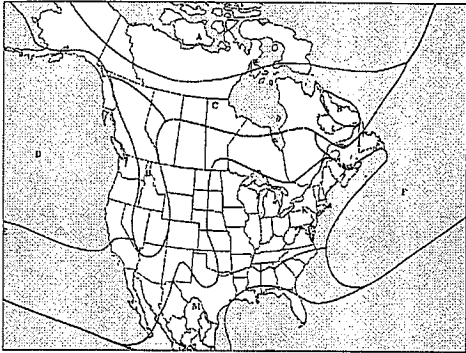
Frequency Reuse

The drawing shown in slide 3-10 represents four LMDS Nodes, designated by the letters A, B, C and D. Each Node has four 90° Sectors, and each Sector provides LMDS services to CPEs in the area supported. Where the Sectors overlap, the coverage area is represented by a shaded area.

Minimal bandwidth is lost in the overlapping area, since SpectraPoint™ LMDS Transmitters and Receivers have antennas that may be polarized horizontally or vertically. Antennas in adjacent Sectors use opposite polarity to provide bandwidth to each Node.



Broadcast Attenuation Factors



- Rain Zone
 - Depends upon intensity
 - Example Rain Rates
 - A = 0.3"/Hr Juneau, AK
 - M = 2.5"/Hr Dallas, TX
 - P = 5.7"/Hr Rain Forest
- Atmospheric density
 - Constant of 0.15 dB/km
- The higher the rain rate, the closer the Node must be to subscribers served.

ITU Rainfall Climate Zone Map

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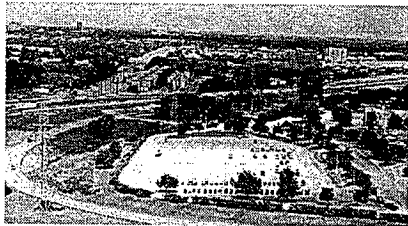
Broadcast Attenuation Factors

See slide 3-11 for details. **Note:** The design objective for SpectraPoint LMDS is 99.99% link availability for each deployment.



LoS Coverage Analysis

Domestic Case Study



Building Type	Building Mix	1-Node Coverage	4-Node Coverage
Single-Family Units	70%	25%	50%
Multi-Family Units	30%	65%	85%
Multi-Tenant Units	Various	70%	90%

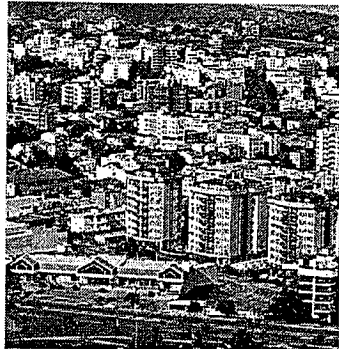
Assumptions: Node antenna height of 200+ feet

Factors affecting coverage:

- Customer density
- Foliage
- Node overlap
- Rooftop height
- Terrain

International Case Study

Building Type	Building Mix	1-Node Coverage	2-Node Coverage
Single-Story	35%	40%	50%
Multi-Story	65%	65%	75%



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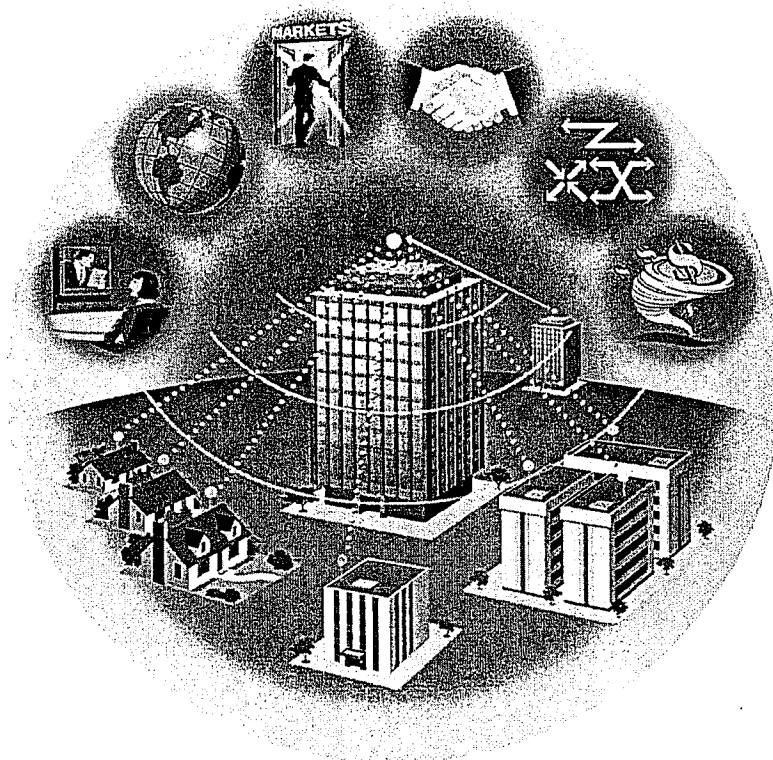
LoS Coverage Analysis

Line of Sight (LoS) coverage analysis is shown in slide 3-12.



WHITE PAPER

"YOUR BROADBAND FIXED WIRELESS SOLUTIONS SOURCE"



SpectraPoint™ Model 2200 Broadband Radio Access System

Product Overview

SpectraPoint™ Model 2200 Broadband Radio Access System

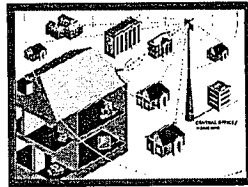
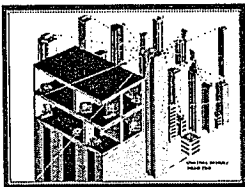
Product Overview

The emergence of New World Network architectures signals an unprecedented opportunity for competitive access service providers. Worldwide Telecom deregulation has spurred competition in the local access markets just in time to capitalize on the explosive growth occurring in the demand for bandwidth and services. Added to these factors is the accelerating role of the Internet as the new global fabric of communications and commerce. The result is a modern day renaissance that presents Telecom service providers with an opportunity to impact the way we work, play, and learn more directly than ever before.

The New World Network arrives unannounced but for the subtle yet profound realization that the amount of data traffic across some service provider networks now exceeds the total of all voice traffic. Networks designed under the voice-driven paradigms of the past will quickly obsolesce in the New World. Communications networks have reached a point of no return, a point of conversion where voice, video, and data traverse a global communications infrastructure - based on Internet technology.

Local Multipoint Distribution Services

- Fixed Wireless @ 28 GHz
- Line of Sight Coverage (LOS)
- Multiple Service Offerings
- Target Deployment/Customers
- Multi-Sectorized Node Sites
- 3 - 5 Km Radius 'Cell' Sizes



Several competing access solutions are scrambling to close the gap between demand for services and available bandwidth. Traditional fiber technology is fine, as long as all of your customers already have fiber to their premises. Various xDSL services are finally being deployed in noticeable numbers for high-end residential customers, yet are inherently less suitable for the more symmetric traffic of

small and medium businesses. Cable modems are promising, but they require significant up-front expenditure to upgrade cable plants, which must be complete before gaining additional revenues. Only broadband wireless solutions such as LMDS offer a "last mile" solution that is rapid to deploy, have expenses that scale directly with the number of customers, and provide a number of configuration options to match any deployment situation.

LMDS for the New World Network

The SpectraPoint™ Model 2200 is the first Point-to-Multipoint (PTM) broadband wireless access system developed specifically for the New World Network. The SP2200 couples a shared broadband downstream carrier with robust, dedicated Frequency Division Multiple Access (FDMA) carriers operating in the range of 2-10 Mbps upstream, producing an ideal system to serve the most profitable segment of the LMDS market - small/medium businesses and multi-tenant dwelling units (MDUs).

The SP2200 utilizes the common SpectraPoint™ 2000 28GHz radio frequency (RF) equipment. This RF equipment has proven its capability in multiple field trials throughout North and South America and Europe. Combining this reliable RF equipment with advanced ATM processing and modem technology yields a flexible and extensible system that is ready to deliver New World services to LMDS customers.

Key Features and Benefits

Maximizes Sellable Bits

The SpectraPoint™ 2200 product maximizes sellable bits through its FDMA architecture coupled with a robust RF transport package. This Architecture minimizes Media Access Control (MAC) related overhead and increases the sellable bit ratio over competing Time Division Multiple Access (TDMA) products, targeted to low-rate/bursty users.

The SP2200 product is based on the proven SP2000 series RF equipment based on state-of-the-art GaAs MMICs to ensure superior link margin and high reliability. Carefully crafted antenna patterns, polarization diversity, and the use of QPSK modulation allow for maximum frequency re-use, to ensure that throughput is maximized across the entire LMDS network.

Product Flexibility

The SP2200 product is designed for maximum product flexibility, to ensure that capital expenditures are made wisely and only when coupled with an immediate revenue impact. There are no stranded assets as the provider is able to deploy only the capacity required to serve captured customers. The provider is also able to easily re-deploy assets as the customer base churns.

Broadband 40MHz Base Channel Groups (BCG) are designed for stand-alone or "rack and stack" environment. They can be installed fully populated or grow in capability as capacity is needed. The shared Time Division Multiplexed (TDM) 45Mbps downstream carrier allows flexible allocation of payload to the user with the highest demand. The provisionable, soon to be dynamic, upstream carrier, allows the provider to serve a diverse set of customers with the bandwidth needed, when needed.

To ensure the effective use of RF power and in recognition that not all deployments are created equal, the SP2200 product provides the ability to serve multiple Base Channel Groups with a single SSPA Transmitter. Each individual hub can be engineered cost effectively as required link availability, link distance and rain zone vary.

Quality of Service (QoS)

The SP2200 product is truly unique in that it is designed to support QoS provisions in today's Service Level Agreements (SLA's). The radio system is no longer just a "wire", but an integral component in the New World Network. The following features ensure that the radio does not become the weak link in the broadband wireless network.

- IP + ATM: IP VLAN mapped to ATM QoS, COS
- FDMA RF Channel sized to ATM Virtual Path
- Supports policy based services through the shaping and queuing of multiple VC's
- Physical and ATM Layer performance statistics available via the Element Management System

Standards Based Interfaces

While SP2200 has been developed for the New World Network, it has been designed to also support legacy interfaces at both the Base Channel Group and the Network Interface Unit.

The Network Interface Unit (NIU) has a built-in 10BaseT port and 4 available slots that can be populated with various combinations of the following Inter-Working Function Cards (IWF).

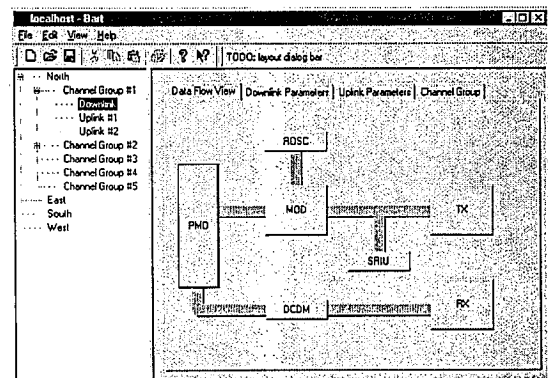
- 2 and 4 * TI/E1 (N*64)
- ATM T1/E1 and FR T1/E1
- ATM-25.6 *future*

The Base Channel Group is designed to interface directly to an ATM switch via a number of factory selectable interfaces including; DS3c, UTP-155, and OC3c (Single-mode/Multi-mode) in the future.

Ease of Installation

These standard features simplify installation of SpectraPoint™ 2200:

- A Windows Based Craft Device and installation script walks the installer through the process.
- The Channel Group mounts in standard EIA 19" racks to allow the equipment to fit the space.
- The Network Interface Unit mounts either in wall mount or standard EIA 19" rack.
- The CPE Roof Unit includes an AGC Port for quick alignment with standard tools.



Craft Interface Device (CID) Graphical User Interface (GUI)

Standards Based Management

The SP2200 uses industry standard management interfaces.

- The Base Channel Group to EMS interface is SNMP
- SpectraPoint EMS for Element Management

Future-Proof Product Design

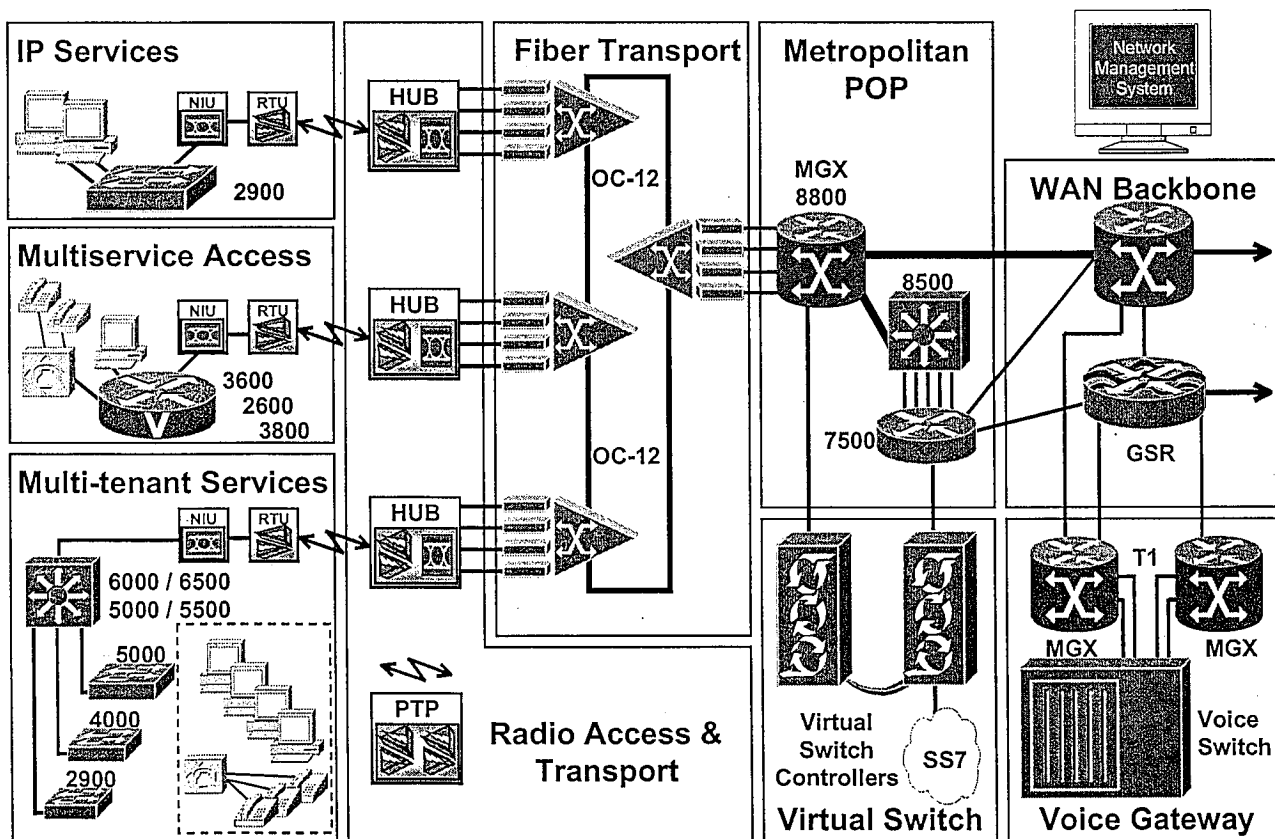
While the SP2200 was conceived to address today's last-mile bandwidth bottleneck, it is also designed to grow without stranding the capital investment. Key feature enhancements are in development today to meet tomorrow's needs:

- Fully Dynamic Bandwidth Control – Upstream and Downstream
- Increased RF Power at both the Node and Customer Premises
- Increased data throughput downstream 155Mbps – Upstream 25Mbps
- Network Interface Unit Suite for tailored applications
- A growing Inter-Working Function portfolio

Reference Architecture

The SP2200 Product is designed to seamlessly integrate at the edge of an existing network or serve as a major building block in the New World Network. The SpectraPoint™ building blocks required are the Network Interface Unit (NIU) and Roof Top Unit (RTU) at the customer premises, and Base Channel Group and Node equipment (Hub). The Node consists of Transmitters, Receivers, and optional radio interface equipment.

Additional key components are the ATM switch solution, Network Management System and Customer Premises Equipment (e.g. routers, switches, channel banks, etc) as shown below.



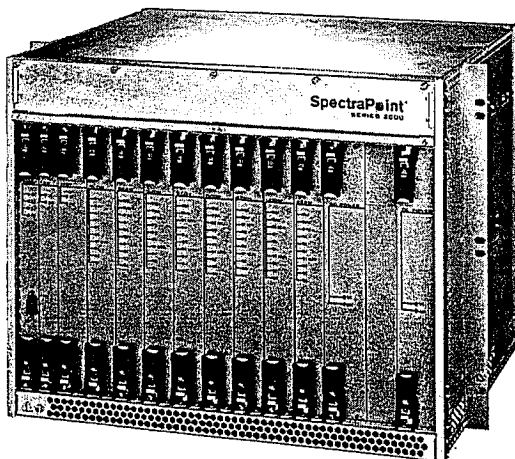
Base Channel Group

The Base Channel Group is the fundamental building block of the SP2200 Base Station. It represents a single 40MHz channel of ATM traffic at a data rate of 45Mbps, packaged in a convenient 8U x 19" EIA form factor. The channel group contains:

- High-Speed Modulator/Up-converter (1)
- Quad Down-converter/Demod (1-8)
- Reference Frequency Oscillator (1)
- Channel Controller/Cell Processor (1)
- Physical Media Dependent Device (DS3, 10/100 BaseT or UTP-155)
- Power Supplies (2)

The Base CG will serve up to 32 Customers with 45Mbps (DS3 option) of ATM traffic and ships standard with load sharing power supplies available as either 110/220 VAC or -48 VDC.

Managed via SNMP, the Base Channel group is accessible for provisioning and maintenance via both RS-232 and Ethernet connections. Channel Groups can be installed in an N+1 configuration to provide channel level service restoration and may be located on-site with or remotely from the ATM switching device. In a contiguous 1 GHz of licensed spectrum, up to 9 Channel Groups (400MHz) may be stacked together in a single 90° sector to meet the service providers needs.



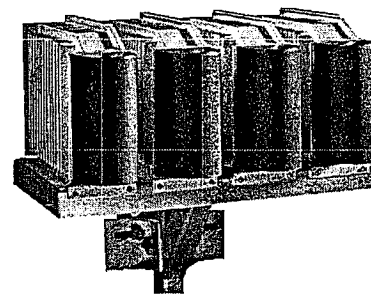
SpectraPoint™ Base Channel Group

Node Transmitter/Receiver

The Node Transmitter and Receiver provide the RF transport function of the SpectraPoint™ 2200 system. These core RF products are used across the entire SpectraPoint™ product line and have been in continuous live operation since April 1998. Node equipment can either be pole mounted or building mounted. Frequency reuse is enhanced via polarization diversity (factory selectable horizontal or vertical).

Operating over the 27.35-28.35 GHz frequency band, the TX2000 is a 1 Watt solid state transmitter, available with either Standard gain (14dBi) or High Gain (21dBi) antennas. Transmitters may be deployed individually or in multiples and are controlled and monitored from the Base Channel Group via an RS-485 connection. A minimum of 1 Transmitter is required per each live 90-degree sector.

The Receiver is an integrated Low Noise Block Converter, Antenna, and Polarizer, designed for 90° sectorization. The RX2000 is installed on the same mounting structure as the Transmitters either alone or in an N+1 redundant configuration. A single Receiver is required per each live 90-degree sector.



***SpectraPoint™ Transmitters / Receiver
(3 TX and 1 RX as installed)***

Sector Radio Interface Unit/Channel Combiner

The SRIU and Combiner are optional pieces of equipment allowing just two coaxial cables (TX and RX) to transport IF signals for multiple Channel Groups from the Base (indoor) to the Node (outdoor) equipment. Used in conjunction, the SRIU and Combiner allows incremental expansion with no additional cabling.

The Combiner frequency multiplexes IF signals at the base station entry/exit point. Packaged in a 2U X 19" form factor, the Combiner is designed for indoor installation.

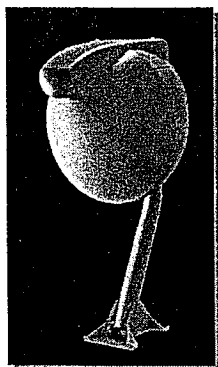
The SRIU provides channelization and amplification of the frequency-multiplexed signal, and distributes these signals to the desired Transmitter. Power, control, and LO reference distribution to multiple transmitters and Receivers, is also performed by the SRIU.

Packaged in a 12U VME form, the SRIU is designed for outdoor installation on the sector mounting structure. The SRIU is designed to accept 8 channel cards of varying frequencies and bandwidths to serve diverse rain area needs, additional channels can be accommodated through upgrade packages. It contains load sharing 1:1 redundant power supplies, local control and monitor, and the switching mechanism that enables N+1 Transmit/Receive Module redundancy.

Customer Premises Equipment

The SpectraPoint™ CPE consists of a Roof Top Unit and a 4-slot Network Interface Unit.

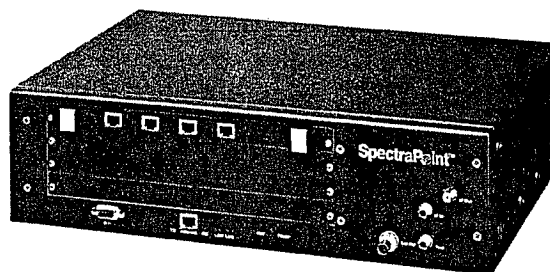
The Roof Top Unit (RTU) or outdoor unit is an integrated antenna and RF transceiver unit providing wireless transmission and reception capability in the 28 GHz frequency region. Selection of polarization (horizontal/ vertical) occurs at installation and is dictated by the Hub-sector Transmitter/Receiver. The ODU mounts on the exterior of a subscriber's building. Alignment is required to gain line-of-sight to the Hub serving the RTU. The RTU requires dual RG-11 cable runs to the NIU for signal/power.



SpectraPoint™ CPE Roof Top Unit

Network Interface Unit

The SpectraPoint™ SP2200 NIU has been designed to offer maximum service delivery flexibility. The NIU is a 4 Slot NIU that is installed within the premises of customers needing 1-4 service interfaces. The 4 Slot NIU is self-contained including the down-conversion/up-conversion, modem, NIU/ODU power supply, and slots for a series of Inter-Working Function (IWF) Cards. IWF Cards provide the interfaces between the SpectraPoint™ Wireless ATM protocol and the necessary customer service protocols (e.g. 4*T1/E1, 10/100bT, etc.).



SpectraPoint™ 2200 NIU

Element Management

SpectraPoint's element management supports complete network management of the SP2200 product line, including fault management, configuration management, performance management, and security management through an SNMP interface. The SNMP agent resides on the CG2200. Information is accessible via a standard 10base-T connection or over the ATM based network connection.

The SpectraPoint EMS also includes a Common Object Request Broker Architecture (CORBA) interface for integrating with other computer systems. Implemented through a client/server architecture, SpectraPoint EMS is hosted on industry standard Hewlett-Packard (HP) and Sun workstations and servers using industry standard graphical interfaces. User stations include Windows NT, HP, and Sun platforms.

**SpectraPoint™ 2200 Product Specifications***Performance Specifications*

Frequency Band	27.35 - 28.35 GHz
Cell Size (system availability)	2-5 Km
Frequency Re-use	up to 4 : 1
Channel Type	TDM/FDMA
Carrier Transmission Capacity	
Downstream	45 Mbps
Upstream	2-10 Mbps Provisionable
Subscriber Capacity/DS Channel	4 – 30
Virtual Circuits/Channel Group	16,000
Virtual Circuits/NIU	1,024
Modulation/FEC Coding	QPSK/Viterbi-Reed Solomon
Downstream Channel Spacing	40 MHz
Transmit Power	
Downstream	1 W
Upstream	100 mW
Antenna Gain	
Base Station (Peak of Beam)	14 dB (Optional 21dB)
Subscriber Terminal	36 dB
Antenna Polarization	Horiz/Vert
Hub Antenna Field of View	
Azimuth	90 degrees
Elevation	19 degrees Basic 30 degrees High-Gain

Physical Specifications

Indoor/Outdoor Unit Separation	
Hub	60m max (300m optional)
Terminal	60m (max)
Temperature Range (ambient)	
Indoor Equipment	0 to +50 C
Outdoor Equipment	-40 to +55 C
Equipment Physical Dimensions	
CPE Terminal NIU	3U x 43.18 cm x 30.5 cm
CPE Terminal RTU	30.5 cm W x 30.5 cm D (max)
Channel Group	8U x 48 x 61 cm
Basic Hub TX/ RX	26 x 10 x 43 cm H x W x D
High-Gain TX/ RX	48 x 10 x 45 cm H x W x D
Equipment Weight	
Network Intfc. Unit	8.0 Kg
Roof Top Unit	6.8 Kg
Channel Group	14.0 Kg
Hub TX/RX Modules	7.5 Kg
Power Supply	
Base CG	-48 VDC or 110/220 at 50/60Hz VAC
Node Outdoor	-48 VDC
CPE Terminal	110/220 at 50/60 Hz VAC
Power Consumption	
Network Intfc. Unit	30W
Roof Top Unit	25W
Channel Group-Max	300W
Hub TX/RX Modules	40W/25W
(w/De-Icer enabled)	90W/75W
Physical Interfaces	
Element Manager	CORBA, SNMP
Subscriber Interfaces	10/100BT, T1/E1(N*64)
Hub Interface	ATM @ DS3/E3
Certifications	
Emissions	FCC Part 15, ICES-003
Transmitter Type Certification	CFR Title 47 Part 101, RSSI-191
Safety	UL1950



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Richardson, Texas 75081
(972) 852-6700
www.spectrapoint.com



SP2200 Base Station Overview

Upon completion of this section, the student will be able to recognize the following SP2200 Base Station equipment:

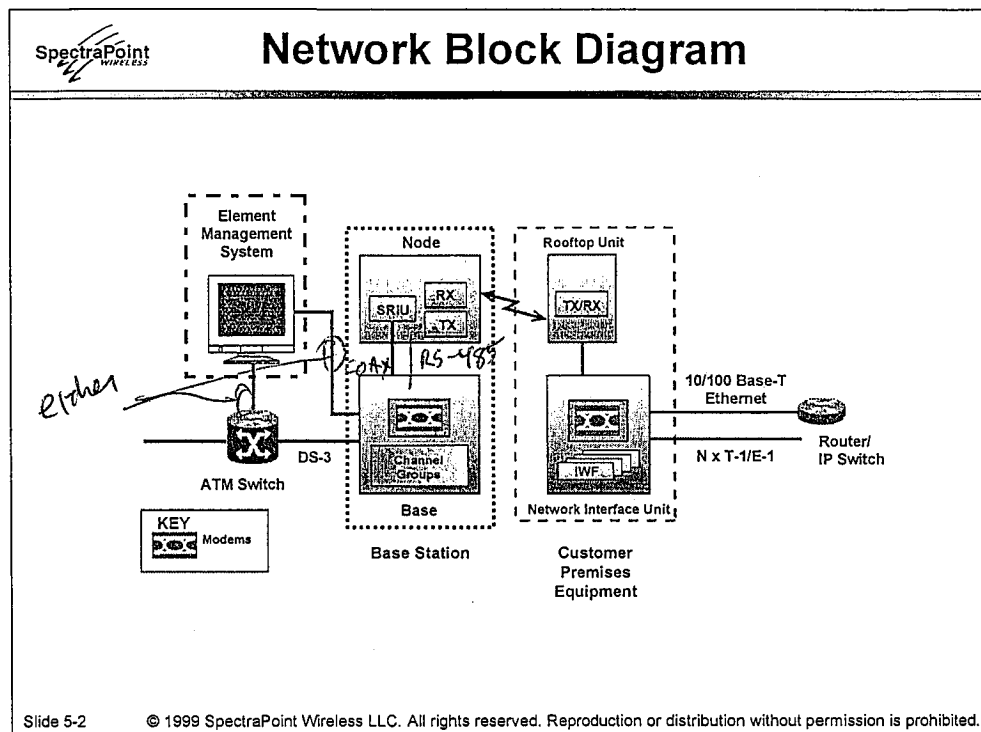
- Base
 - Base Channel Group
- Node
 - Sector Radio Interface Unit (SRIU)
 - Sector Mounting Frame
 - Transmitters and Receivers

Slide 5-1

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SP2200 Base Station Overview

This section overviews the **SpectraPoint™** SP2200 Base Station subsystems, including the network architecture and connections. See slide 5-1 for the section objectives.

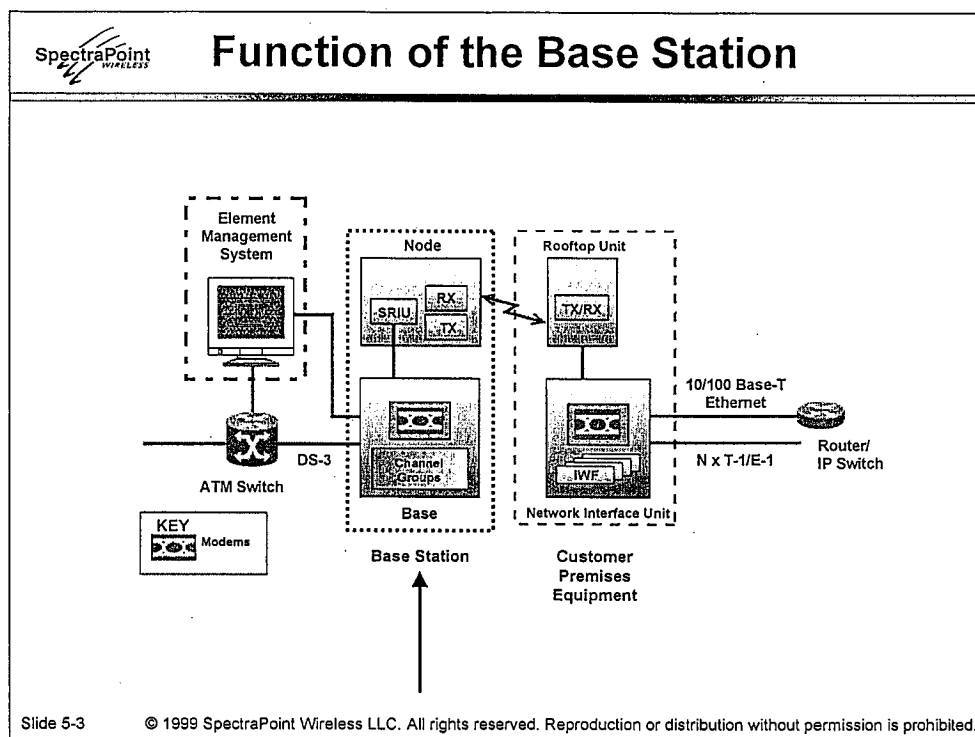


Network Block Diagram

Network Architecture

Shown in slide 5-2 is a drawing of an overall view of an SP2200 LMDS network.

An ATM switch serves as the input to the SP2200 Base Station. Input sources to the ATM switch may include voice, Internet access, Frame Relay, and ATM.



Function of the Base Station

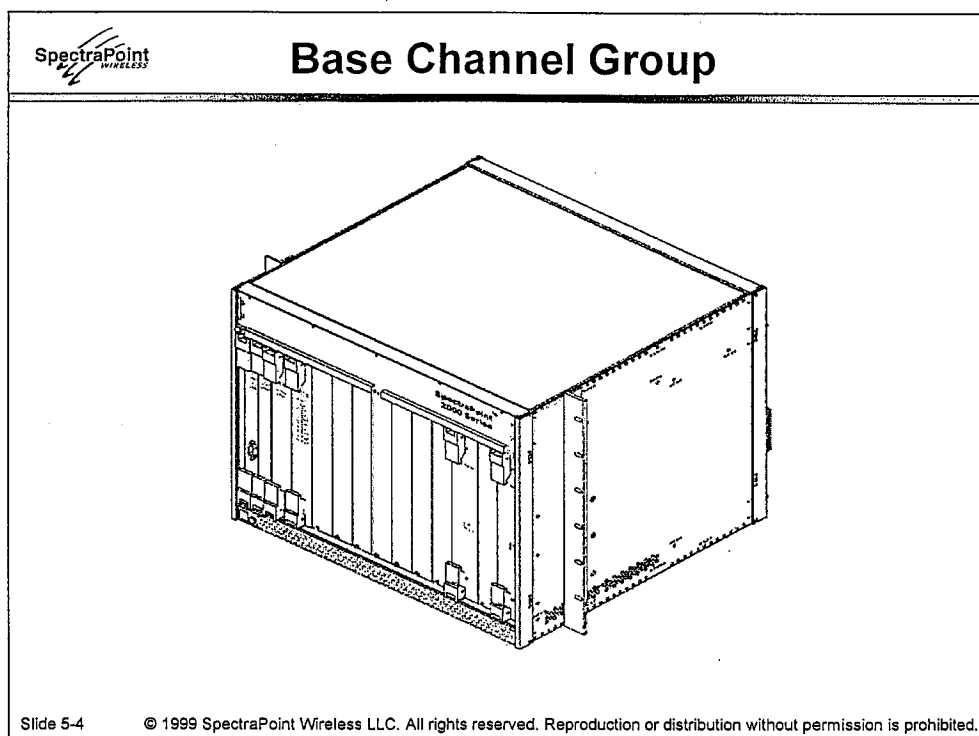
The SP2200 Base Station includes the Base and the Node.

Base

Base Channel Groups take the input of network services as ATM cells on DS-3 ATM links from the ATM switch, modulate and up-convert the signals to Intermediate Frequency (IF), and transport these cells to the Node.

Node

L-band IF is received from the Base equipment and is up-converted to Ka Band at 28 GHz, and transmitted to the Subscribers.



Base Channel Group (BCG)

Shown in slide 5-4 is a drawing of a SP2200 Base Channel Group (BCG). The Base Channel Group supports a broadband TDMA downstream carrier and multiple wideband FDMA upstream carriers. Up to ten BCGs - nine active and one redundant - may be used at the Base to support one sector.

The BCG chassis includes the cell processor, Physical Medium Dependent (PMD) card, broadband modulator, frequency reference, power supplies, and a single quad downconverter/demodulator card.

- The PMD card provides the interface between the ATM switch/network and the SpectraPoint™ RF equipment.
- The cell processor processes ATM cells received from the ATM switch:
 - The broadband modulator modulates and up-converts ATM cells for transport to the Node.
 - The frequency reference provides a 10 MHz frequency standard for the Channel Group, and a port is provided to accept an external reference input.

Base Channel Group (BCG), continued

- It supports up to 8 quad Downconverter/Demodulator (DCDM) cards.
 - The DCDM card down-converts and demodulates the ATM cells being received from the CPEs.
 - Each DCDM card can support four upstream links and the links can vary from 2 to 10Mbps each.
- Dual power supplies provide DC-DC power conversion for the Channel Group in a load-sharing configuration.
- A Channel Group Combiner
 - combines the 9 BCG channels being sent to the Node into a single stream
 - splits the stream being received from the Node into 9 channels for the BCGs
- The BCG chassis is normally installed in a rack with other Base Channel Groups. As an alternate method, a single BCG could be installed on a tabletop.



Node Equipment

- Sector Radio Interface Unit (SRIU)
- Sector Mounting Frame
- Transmitters and Receivers

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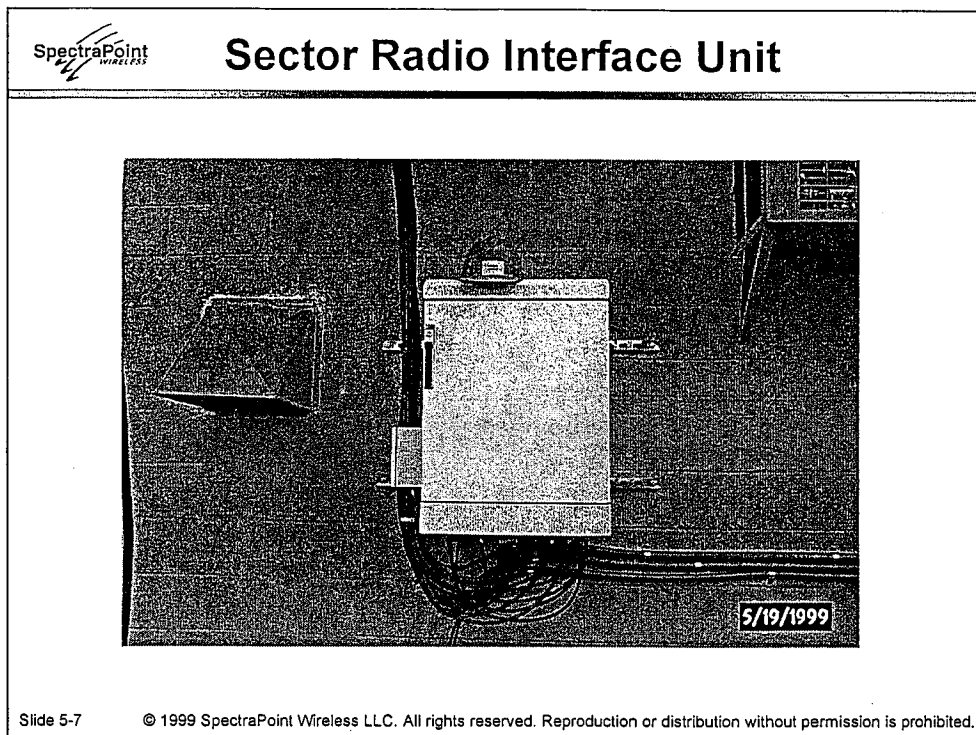
Node Equipment

Nodes broadcast signals from the Base up to a maximum radius of 5.0 km. Nodes are typically located atop buildings, towers, or other tall structures to transmit and receive *Line of Sight* (LoS) signals.

A Node can support four 90° Sectors, and each Sector will have:

- One Sector Radio Interface Unit (SRIU) for connections to the Base.
- One Mounting Frame with a mounting platform for Transmitters and Receivers
- Transmitters and Receivers

Note: *The SRIU will be mounted separately, not attached to the Mounting Frame.*

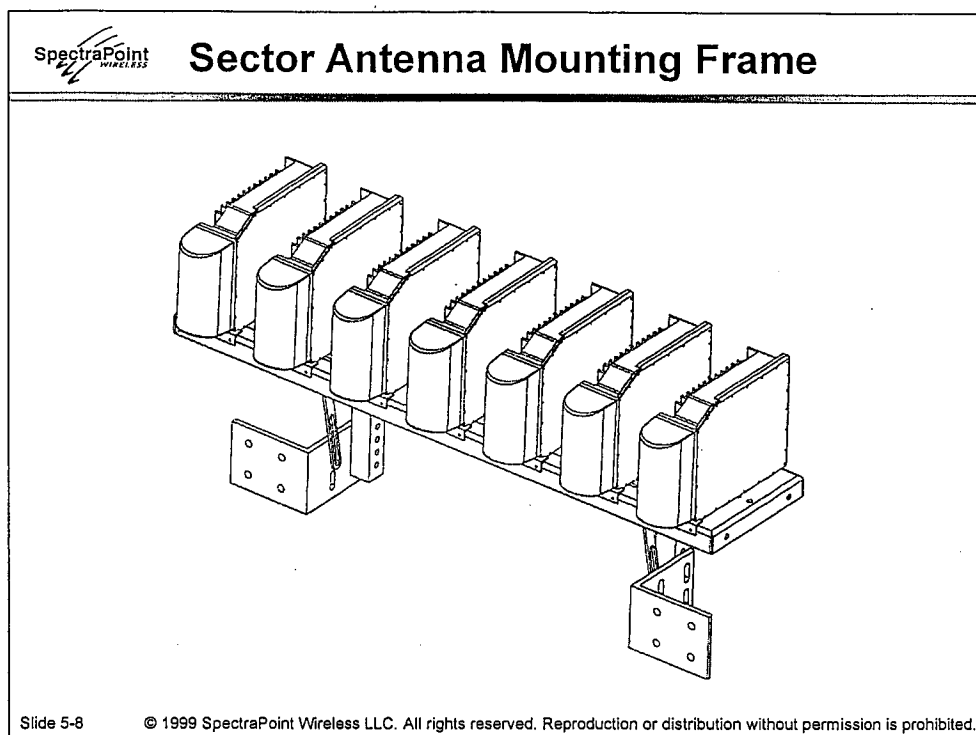


Sector Radio Interface Unit (SRIU)

A SRIU is used to concentrate the L-band (payload) signals between the Base and the Node. This reduces the number of coax cables required to two: one is used for transmit (TX) of the Channel Groups to the Node, and one is used for receive (RX) of the Channel Groups to the Base. There are two additional cables between the Base and the Node at the SRIU - one for RS-485 and one for -48 V DC power.

The connection between the Base and the SRIU may be made using coax or fiber cable, as required by the deployment. Slide 5-7 shows an SRIU installation using coax.

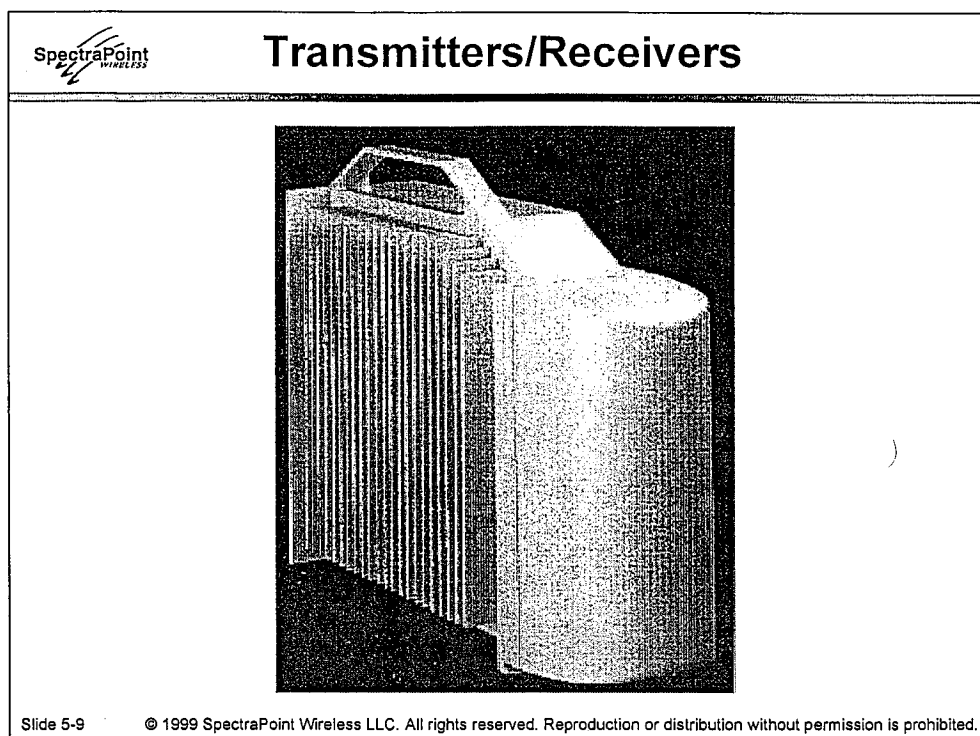
- In this deployment, the unit is installed on the side of an outside structure. A hard hat is shown on top for size comparison.
- Input from the Base is on the right, and the cables connecting to the Sector radios are on the left.
- **Note:** *Using fiber cables between the Base and the SRIU allows longer cable runs, but will require using optical-to-electrical interface devices at each end.*



Sector Mounting Frame

The drawing on slide 5-8 shows a ledge-mount Sector (roof) mounting frame. This is one of many styles available - the style used depends on the customer deployment.

Each fully equipped mounting frame carries the Transmitters and Receivers for one 90° Sector.



Transmitters/Receivers

A photo of a Transmitter is shown in slide 5-9, and this appearance is the same for both Transmitters (TXs) and Receivers (RXs). They share the following common features:

- Horizontal or vertical polarization models
- RS-485 interface for control and monitor from Base
- -48 V DC primary power
- Frequency range: Ka Band of deployed country
 - 28 GHz in the U.S.
- 12 TX/RX maximum per 90° Sector:
 - 10 Transmitters maximum
 - 9 active (1 per BCG)
 - 1 redundant
 - 2 Receivers maximum
 - 1 active (1 per Sector)
 - 1 redundant



SP2200 CPE Overview

Upon completion of this section, the student will be able to recognize the following SP2200 CPE equipment:

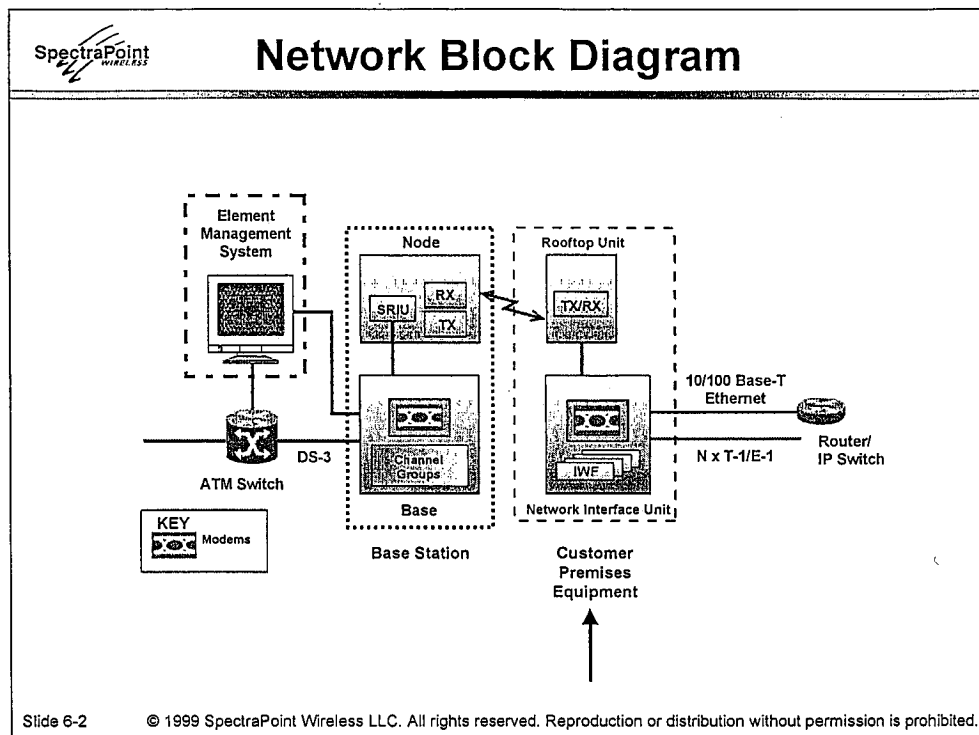
- Rooftop Unit (RTU)
- Network Interface Unit (NIU)
- Subscriber network access equipment

Slide 6-1

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SP2200 Customer Premises Equipment (CPE) Overview

This section provides an overview of the **SpectraPoint™** SP2200 Customer Premises Equipment (CPE); a more comprehensive look at the CPE is available in a separate training course. See slide 6-1 for the section objectives.



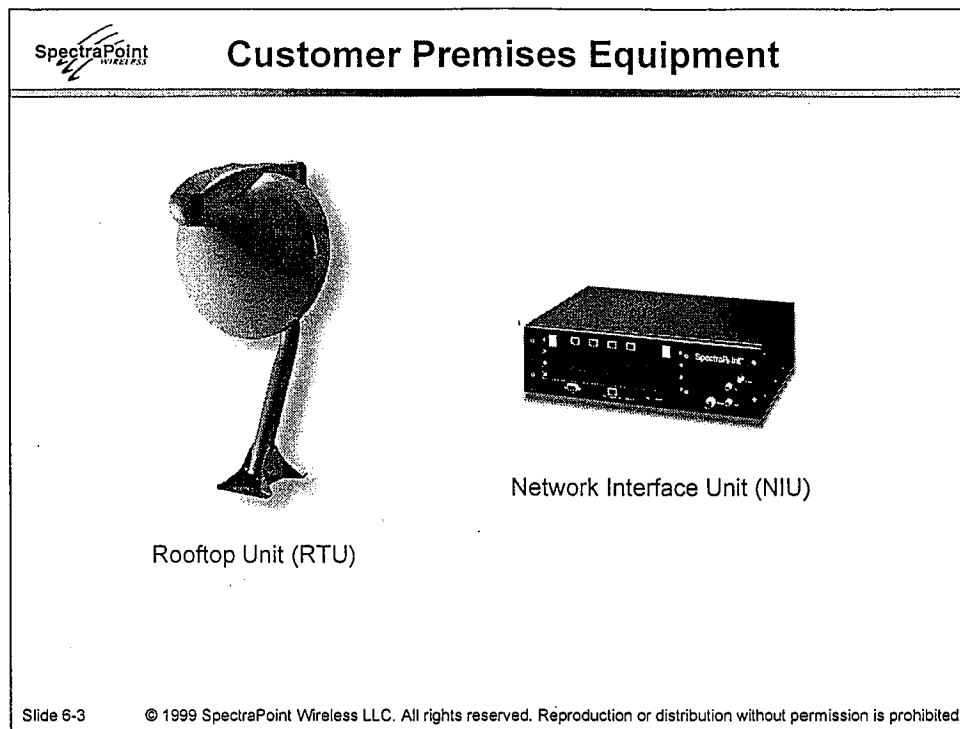
Network Block Diagram

Slide 6-2 shows a diagram of the architecture of an SP2200 LMDS network.

Network Architecture for CPE

- From the Node, services are transported via ATM virtual channels 'Over-the-Air' to a Rooftop Unit (RTU) at each subscriber site.
- The ATM cells are transported from the RTU to the Network Interface Unit (NIU) at the subscriber's location. The NIU provides the interface to the subscriber's equipment.
 - Services include T-1/E-1 CES, N x 64k, and Ethernet (10Base-T).
 - Planned offerings include Frame Relay access, HSSI, Multifunction (8n) cards, and DS-0 grooming.

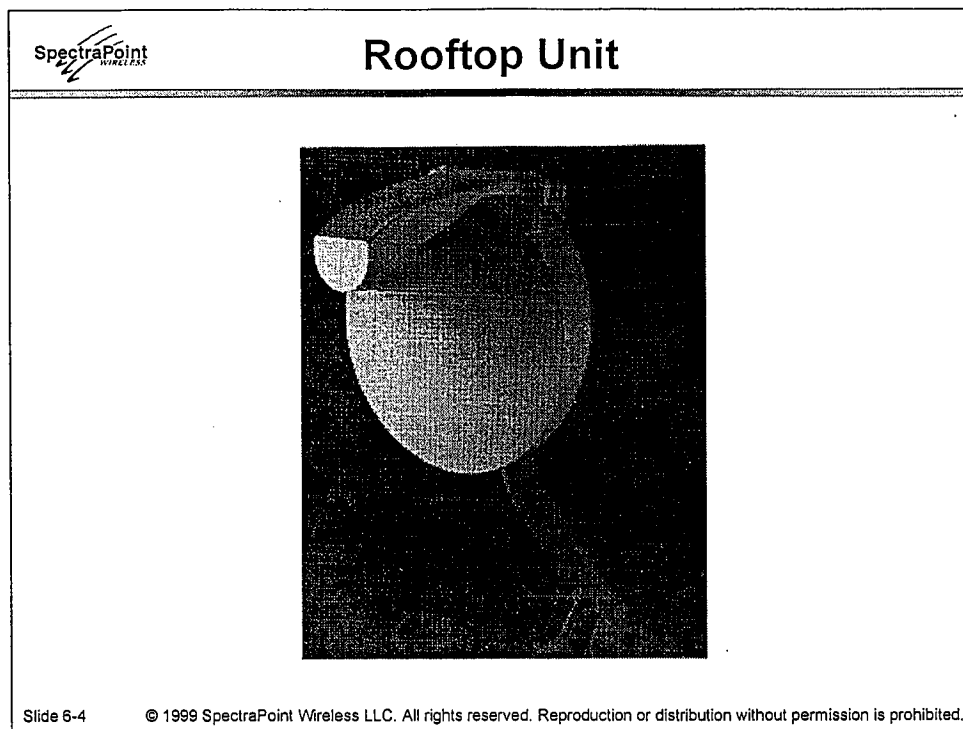
Note: The subscriber network and network access equipment (referred to earlier) is shown on the right side in the slide. This is the subscriber's equipment that connects to the NIU for network access. Subscriber network equipment includes routers, channel banks or other devices; this is not SpectraPoint equipment and may or may not be supplied by the LMDS provider.



Customer Premises Equipment (CPE)

Shown in slide 6-3 are photos of the CPE:

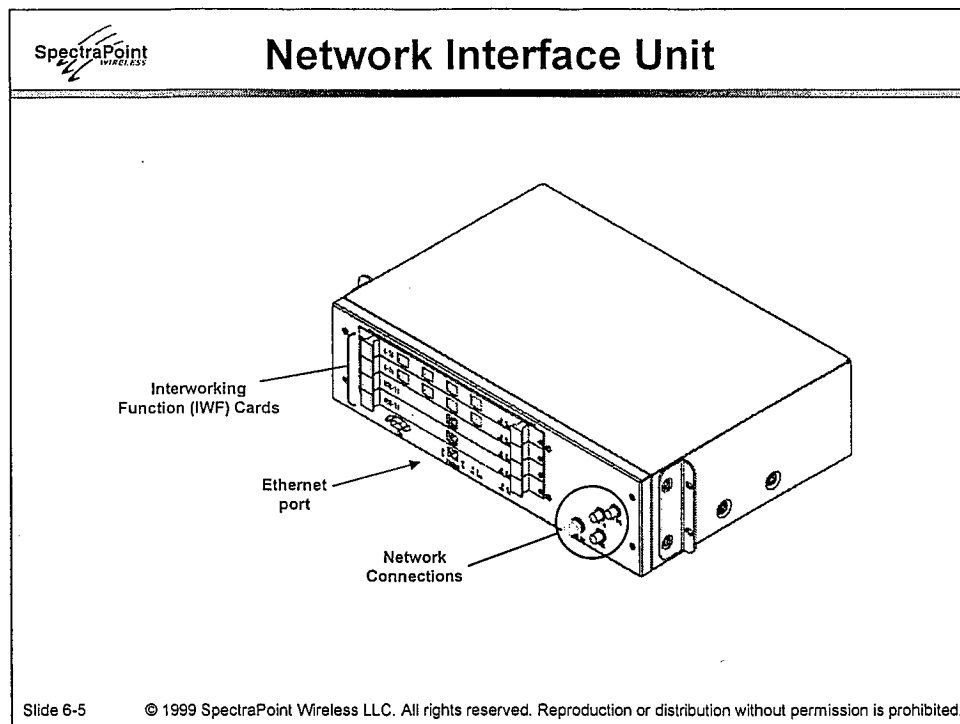
- Rooftop Unit (RTU)
The antenna placed on the roof or other elevated outside position at the subscriber location for receiving the LMDS transport from the Node.
- Network Interface Unit (NIU)
The LMDS unit placed inside the subscriber's premises providing interface to the subscriber's network.



Rooftop Unit (RTU)

Key Features

- Interface between Node and NIU
- Antenna diameter 33 cm/13 in
- Broadcasts applicable frequency for deployment
- Selectable polarization: horizontal or vertical
- Adjustable mounting mast
- Weight 3.6 kg/8 lb
- UL certified
- FCC certified

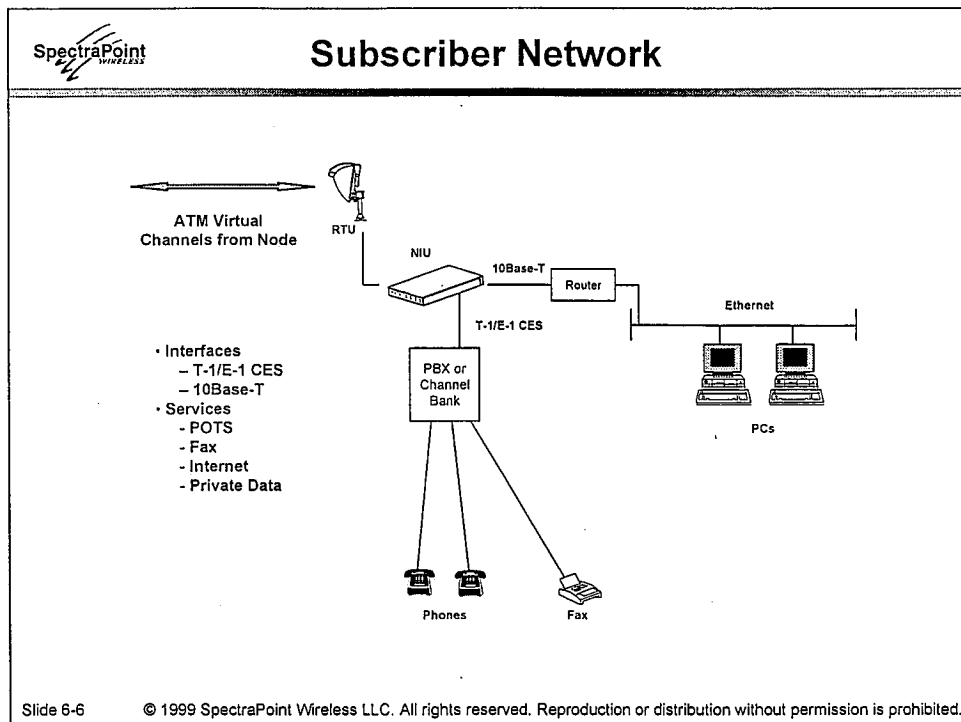


Network Interface Unit (NIU)

Slide 6-6 shows a drawing of the NIU.

Key Features

- NIU has four slots per NIU for supporting Interworking Function (IWF) cards, and a maximum of 3 Circuit Emulation Service (CES) IWF may be used.
 - Each Quad T-1/E-1 IWF card provides four T-1/E-1 CES ports, and each port may be configured for N x 64k.
- 10Base-T (Ethernet) interface built into unit
- Planned offerings include Frame Relay access, HSSI, Multifunction (8n) cards, and DS-0 grooming.
- Rack- or wall-mountable
- Dimensions (W x H x D) 45.7 cm x 10.2 cm x 31.8 cm
18 in x 4 in x 12.5 in
- 110 V AC or 220 V AC
- Weight 7 kg/15.5 lb



Subscriber Network

Slide 6-7 shows a drawing of a typical subscriber network using T-1 or E-1 CES, plus 10Base-T provided by the SP2200 LMDS system.

The ATM virtual channels are received by the RTU and transported to the NIU in the subscriber's telephone closet. In this instance, the T-1/E-1 CES connects to a PBX or a channel bank for voice services (phones and fax), and the Ethernet (10Base-T) interface connects to a router for Internet access.



Operations Architecture

Upon completion of this section, the student will be able to recognize the following components of Operations Architecture:

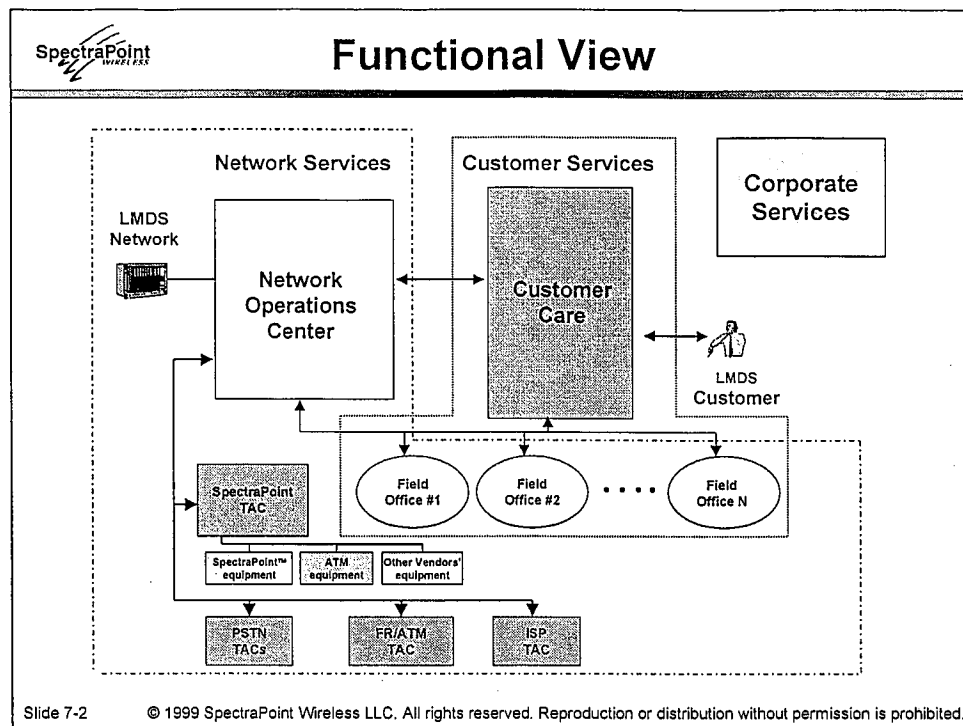
- Network services
- Customer services
- Corporate services

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Operations Architecture

This section presents an overview of Operations Architecture. See slide 7-1 for section objectives.

As we look at each area, we will also discuss the subsystems involved, and its effect on LMDS.



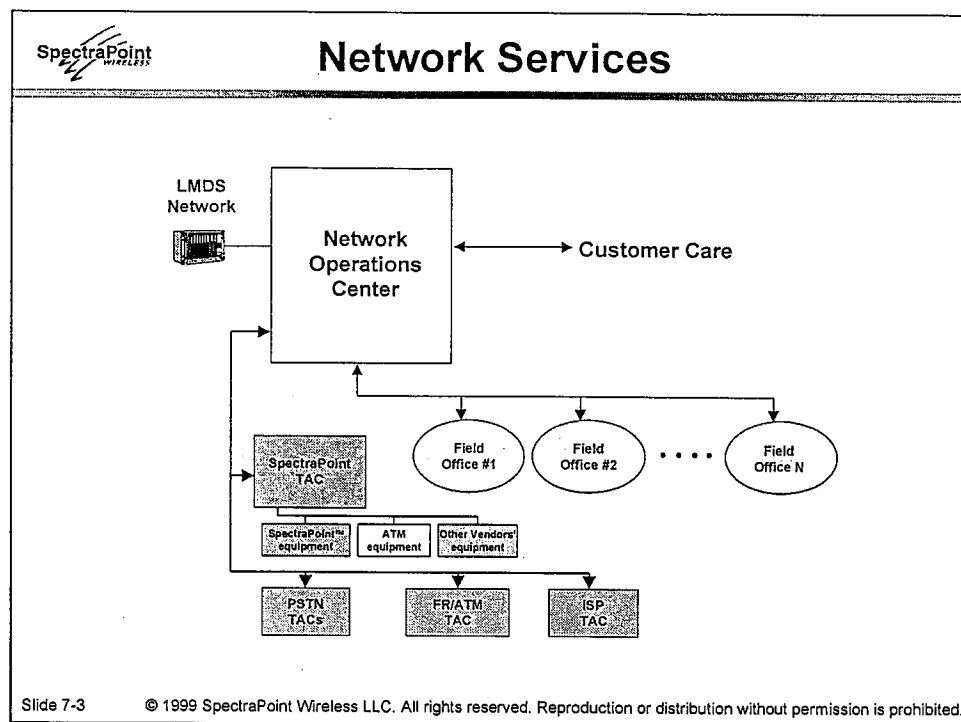
Functional View

Shown in slide 7-2 is a functional view of the Operations Architecture.

It has three major components as illustrated:

- **Network Services**
represented by the alternating (dot/dash/dot) line
- **Customer Services**
represented by the dashed line
- **Corporate Services**
represented by the gray box shown.

Network Services, Customer Services, and Corporate Services are overviewed on the following pages.



Network Services

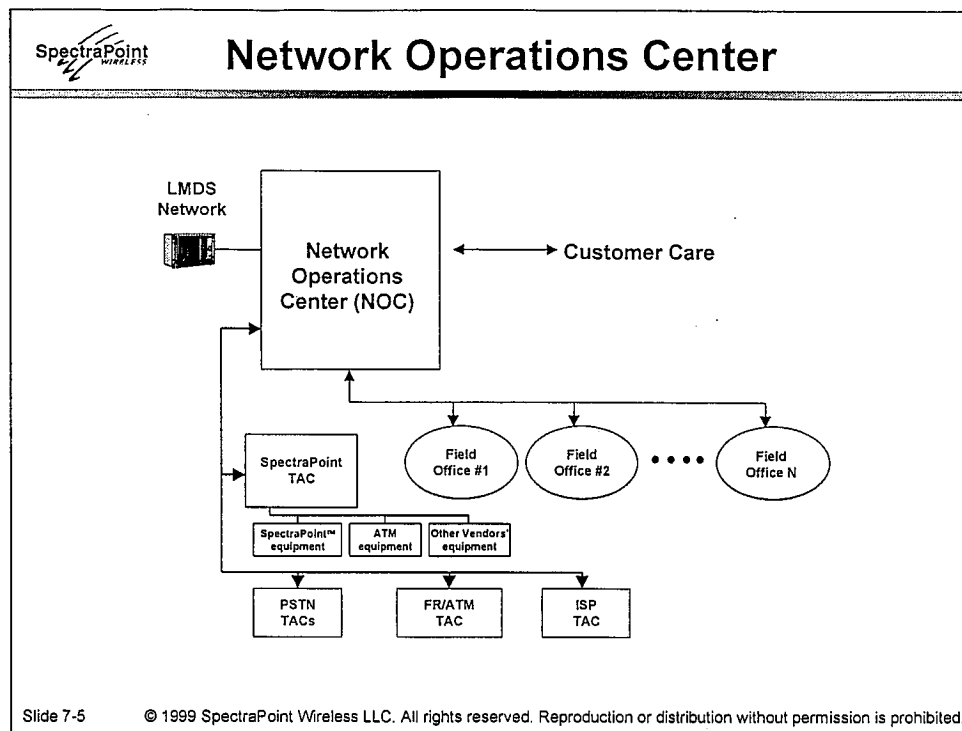
Network Services major components include:

- Network Operations Center (NOC)
 - The NOC is responsible for ensuring the LMDS network availability and provisioning of service. Includes interface to other service providers for pre-ordering, ordering, and trouble ticketing.
- Vendor Technical Assistance Centers (TACs)
 - The TACs are the interface used for major products such as SpectraPoint™, access equipment, and Service Providers.
- Repair Force and Working Inventory at Field Office
 - Scheduling and dispatching of installation & maintenance (I&M) personnel.

Network Services, continued

Network Operations manages the Telecom Network, and provides the Operations Support System (OSS).

- Telecom Network includes all of the network equipment used to deploy LMDS service to customers; provides provisioning of network elements for service, performance management & alarm surveillance, scheduling of repair force, interface for Customer Billings
- OSS includes methods and procedures which directly support the daily operation of the telecommunications infrastructure, often referred to as Operations, Administration, Maintenance and Provisioning (OAM&P).

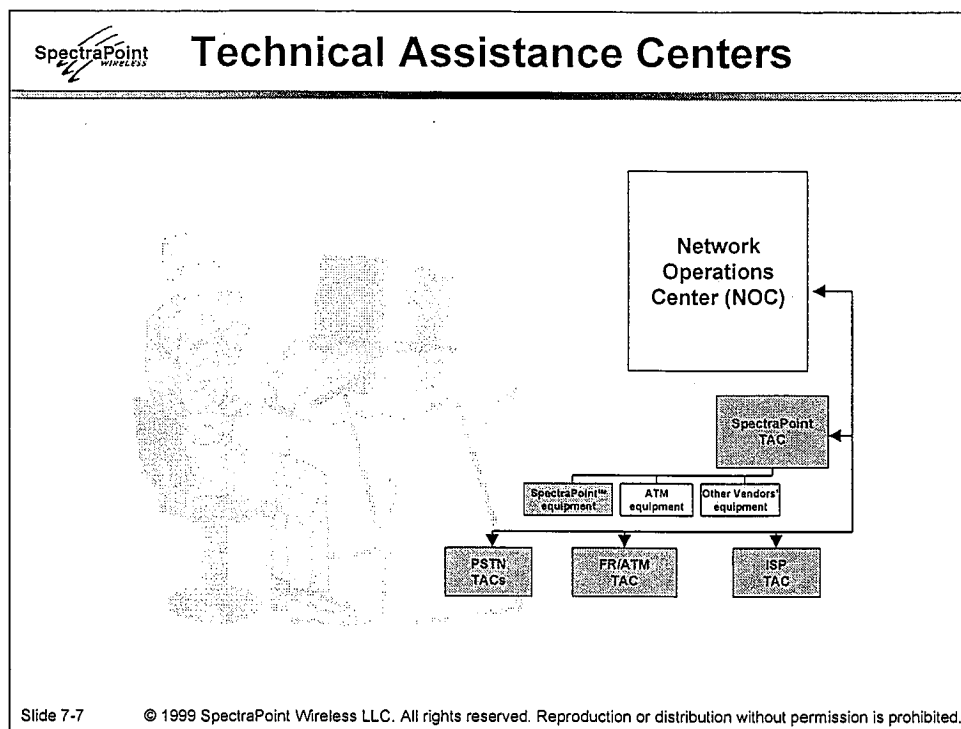


Network Operations Center (NOC)

- Most NOCs have similar 'look and feel'
 - semi-auditorium atmosphere
 - individual workstations
 - GUIs & one or more large screens on front wall
 - redundant on-line databases.
- Established Telephone companies have very experienced NOC personnel; new entries in industry typically have less experienced personnel backed by more capable systems, need craft personnel with multiple services expertise.
- All NOCs include at least Fault Management functionality; new NOCs do not always include performance management or complete configuration management initially (configuration management is responsible for provisioning network elements and being able to query status of network elements).

Network Operations Center (NOC), continued

- Not all NOCs are '24x7' (24 hours/day, 7 days/week) operations; some are manned 16 hours/day on week days and 8 hours/day on weekends with off-hour pager access to personnel who have remote access capability.
- Classical Telephony has Demarcation Point outside premises for Repair Force; LMDS Demarcation Point is within premises complicating Repair Force scheduling process.

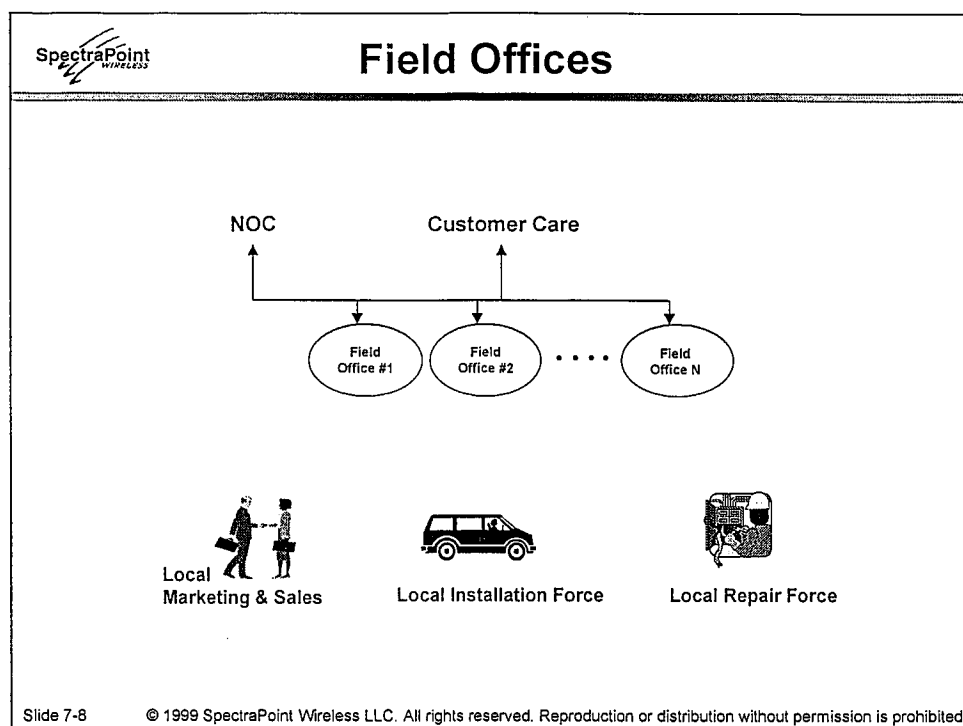


Technical Assistance Centers (TACs)

TACs provide a detailed level of problem assistance for cases that cannot be handled at the NOC or by Customer Care.

TACs are provided for Major Network Elements:

- SpectraPoint TAC
 - SpectraPoint™ LMDS equipment
 - ATM & cross-connect access switch
 - Other vendor equipment used (routers, channel banks)
- TACs for LMDS Access Network
 - PSTN
 - Frame Relay
 - ATM
 - Internet

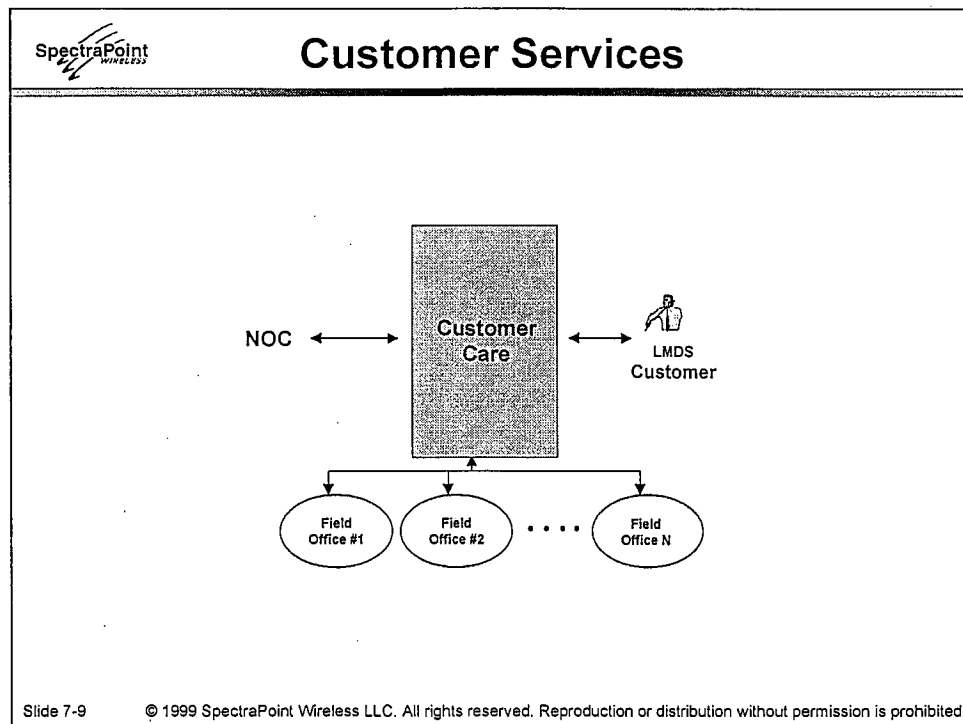


Field Offices

The major functions of a Field Office are as follows:

- Local customer interface
- Local marketing & sales (M&S)
 - building owner interactions to allow presence of equipment and wiring
 - regional target advertising
 - door-to-door sales force to individual customers in buildings (i.e., multi-tenant businesses such as a mall, or apartment dwellers)
- Local working inventory
- Local installation force
- Local repair force.

Field Offices are located as required in LMDS providers' service regions.



Customer Services

- Billing
 - creation of an invoice for multiple services
 - bill stuffing & mailing
 - accounts receivable & account records
- Call Center
 - telemarketing
 - creating orders/provisioning new service
 - billing inquiries
 - trouble ticketing (trouble reporting & diagnosis)
 - warehousing database
- Customer Care
 - handles contacts from customers re: multiple services
- Directory Assistance
 - 1411
 - '0' number inquiries
- Operator Services
 - Operator-assisted calls

Customer Services

Please note that Customer Care may overlap with some Field Office functions such as local contact/walk-in customer care, and installation work force (installation & repair).



Corporate Services

Gives Enterprise Control to LMDS Provider

Example Corporate Functions:

- Corporate management
- Corporate M&S
- Product Management
- Telecom Network Management policy

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Corporate Services

Corporate Services is responsible for overall corporate operations policies. Its functions include:

- Corporate M&S
 - marketing strategy
 - branding
 - pricing
 - advertising
- Field Office Management
- Financial Management
 - asset management
 - auditing
 - budgeting
 - cash management
 - financial reporting
 - investments
 - payroll
 - tracking liabilities, raising equity

Corporate Services, continued

- Human Resources (HR)
 - hiring and firing
 - benefits
- Legal & Regulatory Services
- Operations Policies
- Product Management
- Support Services
 - documentation
 - contractor training (Craft/Install)



Acronyms

A

AAL	ATM Adaptation Layer
AC	Alternating Current
ATM	Asynchronous Transfer Mode
BCG	Base Channel Group
BRI	Basic Rate Interface (ISDN), an ISDN term
bps	bits per second

B

BTA	Basic Trading Area
-----	--------------------

C

CATV	CABle TeleVision, or Community Antenna TeleVision
CBR	Constant Bit Rate
CES	Circuit Emulation Service
CLEC	Competitive Local Exchange Carrier
CO	Central Office
CPE	Customer Premises Equipment
CSR	Customer Services Representative

D

DBA	Dynamic Bandwidth Allocation
-----	------------------------------

DBS	Direct Broadcast Satellite
DC	Direct Current
DDS	Digital Data Service
DSL	Digital Subscriber Line
DSP	Digital Signal Processing
DS-0	Digital Service – Level 0, 64 kbps
DS-1	Digital Service – Level 1, see T-1
DS-3	Digital Service – Level 3, 45 Mbps
DTE	Data Terminal Equipment

E

E-1	2.048 Digital Link, Europe & S.A.
E-3	34 Mbps Digital Link, Europe & S.A.

F

FCC	Federal Communications Commission
FDM	Frequency Division Multiplexing
FDMA	Frequency Division Multiple Access
FTTx	Fiber to the "x"

G

GaAs	Gallium Arsenide
GHz	GigaHertz
GUI	Graphical User Interface

H

H0	H Zero ISDN service, 384 kbps
H1	H One ISDN service, 768 kbps
HFC	Hybrid Fiber Coaxial cable
HP	Hewlett Packard Corporation
HR	Human Resources
HSSI	High Speed Serial Interface
Hz	Hertz, one cycle per second

I

IDU	Indoor Unit
IF	Intermediate Frequency
ILEC	Incumbent Local Exchange Carrier
I&M	Installation & Maintenance
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISDN BRI	ISDN Basic Rate Interface
ISDN PRI	ISDN Primary Rate Interface
ISP	Internet Service Provider
ITU	International Telecommunications Union
IWF	InterWorking Function card
IXC	IntereXchange Carrier (LD company)

K

Kbps	kilobits per second, 1,000 bits per second
KHz	kiloHertz, 1,000 cycles per second)
Km	kilometer

L

LAN	Local Area Network
LEC	Local Exchange Carrier
LMCS	Local Multipoint Communication Service
LMDS	Local Multipoint Distribution Service
LoS	Line of Sight

M

M&S	Marketing and Sales
Mbps	Megabits per second, 1,000,000 bits per second
MHz	MegaHertz, 1,000,000 cycles per second
MMDS	Microwave Multipoint Distribution Service
MMIC	Monolithic Microwave Integrated Circuit

MUX Multiplexer

N

NIU Network Interface Unit

NOC Network Operations Center

NMS Network Management System

O

OPEN NSÜ SpectraPoint™ Network Management System

OAM&P Operations, Administration, Maintenance & Provisioning

OC-1 Optical Carrier – Level 1

OC-3 Optical Carrier – Level 3

OC-12 Optical Carrier – Level 12

ODU Outdoor Unit

OSS Operations Support System

OTA 'Over-the-Air'

P

PBX Private Branch eXchange

PMD	Physical Media Device
POP	Point-of-Presence
POTS	Plain Old Telephone Service
PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network

P

QoS	Quality of Service
QPSK	Quaternary Phase Shift Keyed, a modulation method

R

RF	Radio Frequency
RS-232	U.S. data standard
RTU	Roof Top Unit
RX	Receiver

S

SDH	Synchronous Digital Hierarchy, used in Europe
SONET	Synchronous Optical Network, used in U.S.

SRIU	Sector Radio Interface Unit
STM	Synchronous Transport Mode
STS-1	Synchronous Transport Signal – Level 1

T

TAC	Technical Assistance Center
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
Telecom	Telecommunications

TX	Transmitter
T-1	1.544 Mbps digital link, U.S.

U

UL	Underwriters Lab
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V

V AC	Volts Alternating Current
VBR	Variable Bit Rate
V DC	Volts Direct Current
VPN	Virtual Private Network

Sources

The sources for these acronyms are as follows:

- Desktop Encyclopedia of Telecommunications, 1998, Nathan J. Muller author
- Emerging Communications Technologies, 1997, Uyles Black author
- Newton's Telecom Dictionary, 1997, Harry Newton author
- *Wireless Industry Terms* website